1988-04-01

Attributes of Undergraduates Majoring in Scientific and Technological Disciplines: Perseverance and Commitments

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Attributes of Undergraduates Majoring in Scientific and Technological Disciplines: Perseverance and Commitments

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of

Doctor of Education

April 1988

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ATTRIBUTES OF UNDERGRADUATES MAJORING IN SCIENTIFIC AND TECHNOLOGICAL DISCIPLINES: PERSEVERANCE AND COMMITMENTS

The purpose of this study was first to determine the characteristics that distinguished persisters from nonpersisters in the fields of science and technology; second, to determine the effects of sex, college choice, parental income, parental educational background, GPA, and academic and social integration factors on persistence; and third, to suggest program implementation for assisting students in the science and technology disciplines to make choices in "fit" of characteristics to college environment.

Subjects for this study were randomly selected from a group of 256 juniors at the University of California, San Diego who had initially selected science or technology as an incoming major. A researcher-designed questionnaire, the Strong-Campbell Interest Inventory, and the Pascarella and Terenzini scale were used to collect data for this survey research. The data were tested by chi-square analysis and analysis of variance and t-tests.

Some of the findings of this study indicated that persisters and nonpersisters differed significantly in their satisfaction with faculty interaction and faculty concern for student development and teaching. Significant differences were found between persisters and nonpersisters in their confidence in their ability to persist and in their GPAs. Some of the findings also indicated that nonpersisters were mainly hindered by the competitiveness, the course grades,

and the difficulty of the subject matter. Persisters were aided by prospects of career and job opportunities in the science and technology fields, family support, and the influence of faculty.

DEDICATION

To my mother and father
Arturo and Elesa Watlington
and
Jullian Edwin, my son --

This project I share with you.

ACKNOWLEDGEMENTS

Completing a project such as pursuing a doctoral degree is not always a single-handed accomplishment. Throughout the process of striving to complete the requirements, many of my friends and family encouraged, supported and prayed for me. Without them, this would never have become a reality.

I would like to thank the members of my committee, Dr. Susan Zgliczynski for her support for this study, Dr. Robert Infantino for his help and patience with my writing style, and Dr. Jeff Steindorf from UCSD for sharing of his personal time and energy to see me throughout this project.

To Dr. Billy Vaughn, who gave generously of his time to help me with the computer program and data analysis, I say thank you, your help was invaluable. I would like to thank my parents, Arturo and Elesa Watlington, for being so giving and loving especially during the summer months when I needed someplace to send Jullian. I also want to thank my sisters and my friends Pat and Vivian for listening and encouraging me along when the task seemed so formidable.

Dr. Tom Bond, Provost of Revelle College, deserves an acknowledgement for his financial support in the form of a staff development grant. I am also very grateful to the

students at all four colleges at UCSD who participated in this study.

Most of all I would like to express my appreciation to my son Jullian for relieving my guilt feelings when he understood why I couldn't take him to the movies or when I missed one of his sports activities.

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CHAPTER ONE

STATEMENT OF THE ISSUE

Introduction

The technological influences of our present society have spread rapidly throughout the educational system in the United States. There is a growing national concern for increasing technological training in our schools and colleges and also for developing the technological capacity of the American labor force. As a result, students are discovering opportunities to pursue careers in fields not only in the science and technology area, but also in areas in which the knowledge of computers and other technology has become a necessary skill for performance. In a national survey, 40 percent of high school students favored science and technology as an intended area of study (Krukowski, 1985). This shift of interest is of high concern for institutions of higher education where enrollments are increasing and programs are limited (Table 1). Can those students who will be successful in these disciplines be identified prior to enrollment? Or conversely, should certain criteria be used for dissuading those who appear to be unable to handle the academic rigors that are characteristic of study in the science and technology area?

This study is an attempt to identify student characteristics and college environments that contribute to or hinder

persistence among students in scientific and technological disciplines. More specifically, the study will investigate the attributes of students who pursue majors within the disciplines of science and technology.

Table 1

National Changes in Intended Areas of Study in College: 1975-1984

	1975 Number	1975 % of Total	1984 Number	1984 % of Total	% Change
Art	30,890	3.8	29,883	3.4	- 3.3
English/literature	16,258	2.4	11,426	1.3	- 29.7
Foreign language	11,380	1.4	7,031	0.8	- 38.2
Philosophy & religion	5,690	0.7	2,637	0.3	- 53.7
Biological sciences	65,031	8.0	27,246	3.1	- 58.1
Health & medical	121,120	14.9	132,715	15.1	+ 9.6
Physical sciences	22.761	2.8	14,941	1.7	- 34.4
Engineering	54,463	6.7	105,468	12.0	+ 93.7
Undecided	52,837	6.5	38,672	4.4	- 26.8
Mathematics	19,509	2.4	9,668	1.1	- 50.4
Computer sciences/ systems analysis	13,006	1.6	85,254	9.7	+555.5
Business & commerce	93,482	11.5	167,871	19.1	+ 79.6
Communications	21,948	2.7	32,519	3.7	+ 48.2
Education	73,972	9.1	40,430	4.6	- 45.3
History	11,380	1.4	4,395	0.5	- 61.2
Psychology	29,264	3.6	30,761	3.5	+ 5.1
Social Science	62,592	5.1	64,160	7.3	+ 2.5

Note. Table 1 includes 17 of 29 categories measured by the College Board. "Total" refers to the total number of respondents cited in this report. It should be noted that, while the number of SAT takers fell by 2.1 percent between 1974 and 1984, the number of students responding to this question increased from 812,813 to 878,904 -- about 8 percent.

Note. From "What Do Students Want? Status." by J. Krukowski, 1985, Change, 17, p. 21. Copyright 1985 Helen Dwight Reed Foundation. Reprinted by permission.

Source: College-Bound Seniors, 1984, College Entrance Examination Board

Background

The city of San Diego, the second largest in the state of California, is a rapidly growing and developing area in the southern part of the state. Its expanding population is reflective of the upward mobility and new technological industry that is now characteristic of cities where opportunities for economic growth are on the rise. As a result, industrial and employment changes are occurring in a variety of locations within the city. The growth of the city of San Diego, in contrast with the changing demographics of the student population both statewide and nationally, has been a factor in the enrollment trend at some of the institutions of higher learning in this area. More specifically, the University of California, San Diego (UCSD) has experienced growth that has had a significant impact on technology and science majors. A recent study conducted by the UCSD Registrar's Office indicates that 2,866 students enrolled in science/math disciplines in 1982, while in 1985, in the same disciplines, records show a total of 3,258 students (Report on undergraduate retention rates at UCSD, February 1986). There was also growth in the overall student population during the academic years of 1982 through 1985. Has this growth affected student retention? What institutional programs have contributed to or hindered persistence in the scientific disciplines? The development of an information base and strategies for program implementation in the areas

of student admissions, academic support services, and counseling and career services could be very useful in coping with future enrollment growth.

Throughout its history, the State of California has invested generously in the educational enterprise, and as a result, the expansion of higher education in California has been even more dramatic than in the nation at large. For example, although Californians make up 10.4 percent of all Americans, its college and university students constitute 14.8 percent of such students nationally; its public colleges and universities enroll 16.9 percent of the nation's public college and university students; and its expenditures for these public institutions amount to 13.4% of the nation's total (California Postsecondary Education Commission Report, 1985, p. 9).

As one of the institutions of the nine-campus system of the University of California, UCSD has been admitting undergraduates to its campus since 1964. With its unique system of four semi-autonomous undergraduate colleges, UCSD's enrollment totals have increased steadily since its inception. The semi-autonomous college system at UCSD means that each college has an educational philosophical base (i.e., a set of general education requirements) and an administrative component separate from the central university structure. The provost, the administrative director of the college, maintains a position of academic decision making for the

college but works within the scope of the traditional administrative structure by reporting directly to the Vice Chancellor of Academic Affairs. Faculty members are assigned to academic areas by colleges; however, they are departmentalized by disciplines. Student services, along with academic advising, although college focused, maintain a university-wide central affiliation. Housing facilities are also identified by the colleges but administered centrally through Undergraduate Affairs and Business Services. While many students are attracted to the campus both for its comfortable climate and aesthetic surroundings, it is believed that UCSD's primary inducement is the quality of its programs. Furthermore, the development of a Division of Engineering has coincided with a dramatic increase in science/technology majors. UCSD's fall 1982 engineering student enrollment figures jumped from 2,564 to 3,078 in the fall of 1985 according to data released by the Registrar's Office (Report on undergraduate retention rates at UCSD, February 1986).

UCSD, like many other institutions of higher learning, is concerned with retention of students within academic disciplines. Students who are interested in science and technology disciplines can enter any one of the four colleges at UCSD. The difference in general education requirements, a major factor in distinguishing between the colleges, is not the only characteristic that seems to separate the under-

graduates. The colleges emphasize the subtle and the distinct factors that characterize a student at one college versus a student at another.

Retention, an outcome of an effective educational program, presents a major topic area for research. To declare in advance, or to foretell on the basis of observation, experience, or scientific reasoning, which students will persist in a particular institution or program has been a major objective or goal of institutions of higher learning. Some studies, more generally descriptive than theory-based, are prominent in the literature on this higher education research domain (Spady, 1970; Tinto, 1975).

Tinto has presented a theoretical model of student attrition that is longitudinal in nature and regards persistence or dropout behavior primarily as a function of the quality of the student's interactions with the academic and social systems of the college. The model asserts that students come to a particular institution with a range of background characteristics (e.g. sex, race, academic ability, secondary school performance, family social status) and goal commitments (e.g. highest degree expected, importance of graduating from college). These background characteristics and goal commitments influence how the student will interact with, and subsequently become integrated into, an institution's social and academic system. "Given individual characteristics, prior experiences and commitments . . . it

is the individual's integration into the academic and social systems of the college that most directly relates to his continuance in that college" (Tinto, 1975, p. 96). This issue is also important for perseverance in an academic discipline within a college setting.

According to Tinto (1975), since quality of institution and type of institution (e.g., two year, four year, graduate) are presumably related to the degree to which academic achievement is valued in the collegiate environment, one would expect academic integration to be increasingly important for persistence, relative to social integration, the higher the quality of the institution. UCSD is considered to be a high quality institution; not only is the doctoral degree offered, but UCSD is also recognized as one of the top 50 research schools in terms of federal financial support and the number of Ph.D.'s awarded annually. It would therefore be expected that academic achievement among the students at this institution would be highly regarded.

Academic achievement both at the high school and college level leads to the development of career and vocational choices for most college students. Holland (1966, 1973), in an attempt to develop an occupational classification system closely tied to psychometric research, hypothesized and identified a theoretical relationship between achievement and personality and environmental variables based on four main assumptions. First, in the American culture, most

people can be categorized in terms of six types -- realistic, investigative, artistic, social, enterprising, or conventional -- and each person may be characterized by one, or some combination, of these types. Second, occupational environments can be divided into the same six types, and each environment will be found to be dominated by a particular type of person. Third, people search for environments that will let them exercise their skills and abilities, express their attitudes and values, take on problems and roles they find stimulating and satisfying, and avoid chores or responsibilities they find distasteful or formidable. Fourth, behavior is determined by an interaction between a person's personality and the characteristics of his or her working environment.

Holland described the effects of different environments on various types; for example, he pointed out that investigative, artistic, social, and conventional types usually do well in school because they have attitudes and values compatible with those of their teachers and thus find the school atmosphere supportive.

Campbell (1971) incorporated Holland's early theory, along with Strong's (1930) vocational interest empirical data, and developed an interest inventory that is widely used to assess vocational interests and characteristics. Holland's theory, coupled with Strong-Campbell's occupational and interest research, will be used to provide a focus

for analysis of data within this study. The Academic Comfort scale, an index of the degree of comfort that a person feels, or might feel, in an academic environment, especially a high-quality liberal arts and science environment, is one that will be utilized along with the Holland codes.

Recent research literature has indicated that the new generation of students has embraced the concept of self-advancement and development. The lure of lucrative salaries and comfortable life-styles has spurred an increase in the enrollment of students in the fields of science and technology, where high-paying jobs have become the norm. Do the students who choose the science and technology disciplines persist within these fields? Can an investigation using instruments that provide data as to the development of specific vocational interest also provide information on persistence in academic areas? Are there some characteristics that are common among science and technology majors? This study looks at the effects of student characteristics and persistence in science and technology fields.

As the student population becomes more diverse, the reasons for persistence become more complex. Unfortunately, the bulk of the literature is concerned with characteristics that predict persistence in college in general and not in a specific academic area. Information concerning the academic interest of high school students points to an increase in the number of students choosing science and technology;

therefore, an investigation that focuses on attributes and commitments of undergraduates within these fields seems necessary and appropriate.

Statement of the Problem

This study examines persistence in the fields of science and technology among juniors at a midsized, selective public institution in the state of California. Specifically, this study attempts to address the question: What are the effects of college choice, sex, G.P.A, parental income, and academic and social integration factors on persistence among science and technology majors? Tinto's (1975) theoretical model attributes persistence to student commitments to their specific institution and to the goal of college completion. Commitments, in turn, are seen as being determined by the student's integration into the academic and social systems of the institution. This study utilizes the concept of academic and social integration factors framework, as explained by Tinto. Emphasis is placed on determining the effects of the different academic requirements at the four colleges of UCSD on perseverance in the field of science and technology. The sample of students is taken from the population of students who have attained junior status.

The study contains both quantitative data from student records and their own reports, and qualitative information from the administration of tests and surveys.

Significance of the Study

According to Tinto's theoretical model of attrition, a variety of external forces affect a person's decision to stay in college. Some of these factors are: the changing supply and demand in the job market; alternative forms of activity (e.g., travel, apprenticeships, etc.) perceived as being potentially more rewarding; and the easing of restrictions, such as repeal of the draft law.

The new technological emphasis in today's society has spurred an increase in the number of students who choose science and technology as major fields of study. As a result, a high-quality science/technology institution such as UCSD attracts a large number of high school graduates. What are the attributes of these students? How persevering are these students who choose to major in science and technology? This study attempts to find answers to these questions.

Students who come to UCSD have to choose one of the four colleges, each of which has a unique set of general education requirements. This is not unlike other universities where the academic departments determine the general education requirements for a particular major. Information gathered from this study could therefore be used by academic counselors to advise students during the freshman year concerning the distinctiveness of the requirements among the colleges in the fields of science and technology and the transferability to other institutions both within and out-

side the UC system. The main importance, however, would be to identify the characteristics that are related to persistence within the fields of science and technology. Identifying college environmental factors that contribute to persistence would be helpful to incoming students so that their decisions would be made based on the knowledge of "fit" between individual characteristics and college environment.

Tinto's model states that persistence is the result of commitments to the goal of college completion and to the student's particular institution. These commitments are modified by the academic and social experiences the students have while enrolled at an institution. Information gathered from research studies could be used to justify the channeling of resources into areas such as admissions and academic support services so that programs could be initiated to retain more students in the science/technology disciplines. In addition, target groups, based on the research results, could be identified and further evaluated for success within the fields of science and technology. The results from a study such as this one could be useful in developing institutional programs and strategies to alleviate the oversubscription in the fields of science and technology by students who do not possess the characteristics needed to persist in the scientific and technological majors.

Hypotheses

The following null hypotheses are being tested.

Demographic considerations:

1. There is no significant difference between students who persist in science/technology majors versus nonpersisters attributable to college affiliation, as determined by data collected from the UCSD registrar's office.
2. There is no significant difference between persisters and nonpersisters attributable to sex, as determined by data collected from the UCSD registrar's office.
3. There is no significant difference between persisters and nonpersisters attributable to sex and college choice combined, as determined by data collected from the UCSD registrar's office.
4. There is no significant difference between persisters and nonpersisters attributable to grade point average (GPA), as measured by the researcher designed Student Questionnaire.
5. There is no significant difference between persisters and nonpersisters attributable to parental income, as measured by the researcher designed Student Questionnaire.
6. There is no significant difference between persisters and nonpersisters attributable to parental educational background, as measured by the Student Questionnaire.

Environmental considerations:

7. There is no significant difference between persisters and nonpersisters based on the following factors: Peer group interactions, interactions with faculty, faculty concern for student development and teaching, academic and intellectual development, and institutional and goal commitments.
   a. There is no significant difference between persisters and nonpersisters based on peer-group interactions alone.
   b. There is no significant difference between persisters and nonpersisters based on interactions with faculty alone.
   c. There is no significant difference between persisters and nonpersisters based on faculty concern for student development and teaching alone.
   d. There is no significant difference between persisters and nonpersisters based on academic and intellectual development alone.
   e. There is no significant difference between persisters and nonpersisters based on institutional and goal commitments alone.

Student interest considerations (as measured by SCII):

8. Persistence is independent of academic comfort.
9. Persistence is independent of science-related interests (identified by Holland 3-letter code).

Definition of Terms

Social Integration: As used in this study, the quantity and quality of informal peer group associations, involvement in semi-formal extracurricular activities, and overall interactions with faculty and administrative staff within the college (Tinto, 1975).

Academic Integration: Students' academic performance in college and the adequacy with which they identify with the prevailing academic norms (Tinto, 1975).

Persisters: Students who have indicated science or technology as their intended major and have not changed to a major outside of science and technology by their junior year.

Persistence: The act of continuation of enrollment in the major of choice as an incoming freshman student.

Science and Technology Majors: Academic disciplines which include the following: Applied Mechanics and Engineering Sciences (AMES), Biology, Chemistry, Electrical Engineering and Computer Science (EECS), Physics, and Mathematics.

Junior Status: The point at which a student has accumulated at least ninety quarter units, but less than 135 (i.e., 60-90 semester units).

Academic Comfort: The scale, as tested by the Strong-Campbell Interest Inventory (SCII), which indicates the degree of comfort in being in an academic setting.

Holland Codes: There are six general themes that have been classified by Holland (1966, 1973). These categories gener-

ally resemble the dimensions seen in research on vocational interests. The six types are Realistic, Investigative, Artistic, Social, Enterprising, and Conventional.

Limitations of the Study

There were some factors that may have placed some limitations on this study. One such factor concerns the population studied. Subjects for this study were drawn from a single institution or sample population, which may limit generalizability; however, the college system at UCSD, although unique in structure, draws from a wide variety of students from public and high school programs statewide. Students were selected based on their status during the fall quarter of 1984, but the surveys were not completed until the fall of 1985, with follow-ups in the spring of 1986. It is difficult to determine whether or not further decisions were made as to career changes during this period.

In each testing situation, there were different numbers of participants. Sometimes the testing was done individually, thereby providing much more individual contact with the researcher during the discussion phase. The testing of subjects was administered at different times and intervals. This factor could be considered a limitation of the study.

Although the researcher used personal contact and a very small financial incentive for participation towards the end of the project, participants indicated that this was not the determining factor for their participation. This factor

of paid volunteers could also be construed as a limitation of the study.

Assumptions of the Study

It was assumed that students made a reasonable effort to answer the questions and to do so in good faith. It was also assumed that students were not coerced to participate in this project through to the end. Follow-up techniques were vigorous in order to produce an adequate percentage of respondents.

CHAPTER TWO

REVIEW OF THE LITERATURE

This study is concerned with the persistence of science and technology majors at a mid-sized university in southern California. In this chapter the theoretical framework for understanding persistence is presented first; then some major topics such as institutional relationship, student characteristics, population, college fit and commitment, academic integration, attrition, and persistence are reviewed.

Institutional Relationship

The need for theory-based research is cited consistently throughout the attrition/retention research literature. Comprehensive frameworks of persistence have been presented by Spady (1970, 1971) and then expanded upon by Tinto (1975). Clearly both student and institutional characteristics were associated with persistence. In addition, persistence was conceptualized both within a discipline and within an institution. According to Spady (1970):

> The dropout process is best explained by an interdisciplinary approach involving an interaction between the individual student and his particular college environment in which his attributes (i.e. dispositions, interests, attitudes, and skills) are exposed to influences, expectations, and demands from a variety of sources (including

> courses, faculty members, administrators, and peers). The interaction that results provides the student with the opportunity of assimilating successfully into both the academic and social systems of the college. To the extent that the rewards available within either system appear insufficient, however, the student may decide to withdraw. (p. 77)

Tinto's theory expanded on Spady's model by emphasizing that when the rewards received through these systems become inadequate, students may consider other alternatives to maximize their returns. Tinto (1975) stated:

> One must view dropout from college as the outcome of a longitudinal process of interactions between the individual and his institution (peers, faculty, administrations, etc.) in which he is registered. Assuming unchanging external conditions, dropout is taken to be the result of the individual's experiences in the academic and social systems of the colleges. These experiences lead to varying levels of normative and structural integration in those collegiate systems and to the reevaluation and modification, if need be, of commitments to the goal of college completion and to the institution. Given the perceived returns to alternative agencies, changes in these commit-

> ments are seen as leading, in varying ways, to persistence or to differing forms of dropout behavior. (pp. 103-104)

Tinto also made two important additions to Spady's model. These were the concepts of educational expectation (aspiration) and institutional commitment. Educational expectations represent the level (e.g. two- or four-year degree) of education desired and the intensity with which that goal is held. Institutional commitment, on the other hand, refers to the extent to which one is predisposed to attendance at a particular college.

Tinto (1975) divided the research into individual characteristics (family background, personal factors, past educational experiences, goal commitment), interaction within the college environment (academic integration, social integration, and institutional commitment), and institutional characteristics (type, quality, size). He felt that voluntary versus forced withdrawal should be considered. According to Tinto, the literature suggested that socioeconomic status factors were inversely related to college persistence (p. 99), that ability (as measured by things like GPA, SAT) was a very important factor (p. 100), and that commitment and personality characteristics of dropouts made success in college more difficult for nonpersisters than for persisters (p. 102). Tinto concluded that the sex of the student was related to college persistence, with a

greater proportion of men finishing college than women (p. 101).

Fetters (1977) developed an extensive study of both public and private high school seniors in 1972 that included all fifty states and the District of Columbia. This study employed a longitudinal design to examine the relationship between five classes of classification variables (i.e., predictors) and college persistence-withdrawal status. These variables were:

1. Bio-social background (family socioeconomic status, sex, and race);
2. Ability (high school grades and standardized test scores) and educational aspiration;
3. High school curricular programs;
4. Student perceptions about the quality of most faculty members, social life on campus, and intellectual development; and
5. Financial aid.

Fetters found that, to some extent, all of these variables, except sex, were related to persistence behavior in four-year and two-year institutions. In general, socioeconomic status (SES) was related only to withdrawal from four-year colleges. This seemed to suggest, according to Fetters, that low SES students may be financially hampered in the four-year college since four-year colleges are more expensive. Financial aid was related to four-year college with-

drawal after SES and aspiration were considered, and the relationship was stronger among low SES and high aspiring students.

When race alone was considered, Fetters found that there were no substantial differences among blacks, hispanics, and whites. However, when SES and sex were held constant, there were race "effects" for the four-year college student.

High school grades were more strongly related to withdrawal behavior than were standardized test scores. This finding was consistent with previous findings (Astin, 1975) that high school grade-point average was a better predictor of college academic performance than was measured aptitude.

Educational aspiration was measured by the respondent's indication of the level of education he or she would like to attain. Aspiration was a strong predictor of withdrawal behavior even when SES and aptitude were controlled. The issue of educational aspiration was very closely related to that of motivation of college students to persist or not to persist. If students were not motivated, they would aspire to lower levels of education, and according to the results of Fetters' study, they would have a high probability of withdrawal.

Fetters' findings indicated that a greater proportion of withdrawals than persisters were students dissatisfied with the quality of the faculty and with their own intellec-

tual growth and development of skills. This finding seemed to support Tinto's (1975) concept that the degree of integration into both social and academic systems of an institution influences withdrawal behavior.

Fetters' utilization of the log-linear model analysis did not reveal many significant interaction effects of classification variables on withdrawal behavior. He concluded that, generally, college withdrawal was a simple function of the main effects of multiple variables.

Since the time of Fetters' findings, other longitudinal studies have been conducted by Pantages and Creedon (1978), Astin (1977), and Pascarella and Terenzini (1979) that have provided information concerning dropouts and attrition which confirmed attrition as a multifaceted (i.e., affected by student and environmental characteristics) phenomenon by using statistical methods of discriminant analysis and multiple regression.

Astin (1975, 1977) reported his findings based on characteristics of entering freshmen. He found that by using a questionnaire that covered such areas as sex, race, parental background, income, occupation, goals, study habits, educational plans, sources of financial support, and student's perception of possible college outcomes, he could identify persisters in college. In his 1977 study, Astin reported that entering freshman characteristics produced only a modest prediction of persistence. He described the

persister as an individual with high grades, high aspirations, affluent parents, and an ability to postpone gratification.

In assessing the effects of environmental characteristics associated with persistence (e.g., type of institution, size of institution, place of residence, etc.), Astin found that living in a dormitory during the freshman year exerted the most influence (p. 109). Further, Astin asserted that all forms of involvement -- research, honors program, social fraternities, and clubs -- are positively associated with persistence; however, the single most important predictive variable is the student's grade point average (p. 260).

Feldman and Newcomb (1969) presented a comprehensive review of empirical data on the impact of college on students. Their findings were based on intensive examination of statistical analysis of hundreds of research studies and are related to Tinto's later work. Feldman and Newcomb suggested that by measuring the correlation between various measures of students' needs and environmental pressure, one could discover the degree of congruence between the student and his or her environment. Attrition then became a function of the congruence between the needs, interests, and abilities of the student and the demands, rewards, and constraints of the particular college setting (p. 289). The essence of the theory was to study the interaction of individual characteristics with college environment: "A given

student characteristic that may encourage withdrawal at one type of college may be irrelevant at another type, and may even promote persistence at a third" (p. 291).

Others, using discriminant analysis (Mathis, 1976; Nichols, 1976; Pascarella & Terenzini, 1980; Santa Cruz, 1980; Townsend, 1975; Vorreyer, 1963), reported successful prediction rates ranging from less than chance to a high of 84 percent. Generally, the discriminant function has proven more accurate in predicting persistence than in predicting non-persistence.

Several authors concluded that timely and carefully planned institutional interventions could significantly reduce the attrition rate (Fetters, 1977; Knoell, 1964; Pascarella & Terenzini, 1980; Sexton, 1965). Pascarella and Terenzini (1980) conducted a longitudinal study of entering freshmen at Syracuse University, a large independent university in central New York State with a total undergraduate enrollment of approximately 10,000 students. Results from this study have been the topic of several analyses by Pascarella and Terenzini and have provided information on such issues as student-faculty informal contact and freshman year voluntary persistence/withdrawal decisions. The development of a measure of institutional integration by Pascarella and Terenzini, and subsequently the performance of the five institutional integration scales in their 1980 study, suggested that the scale may be useful in identifying potential

freshman year dropouts during the second semester of the freshman year. According to Pascarella and Terenzini, "Theoretically, discriminant analysis could be employed to develop a predictive equation based on the five scales which may be used to identify those students with a high probability of withdrawing. Random samples of these students might be obtrusively assigned to various experimental and control groups to determine the effectiveness of institutional interventions designed to decrease voluntary dropout rates" (p. 72).

Pantages and Creedon (1978) also suggested that even though students may ultimately decide to terminate studies, the involvement by college personnel in the decision making process might be important in subsequent decisions to re-enroll at the institution. Pantages and Creedon (1978) also noted that research has failed to establish true relationships among levels of motivation, commitment to college, strength and content of educational goals, and attrition. Their conclusions related to motivational factors suggest that such factors may be "far less important in determining persistence and attrition than has been traditionally assumed" (p. 71). This suggestion was made in spite of the literature which indicated that motivational level and commitment are important (p. 65), that parental influence is important (although that influence is certainly mediated by

the parent-student relationship), and that a positive peer-group relationship is associated with persistence (p. 70).

Student Characteristics and Persistence

The focus of much research has been on student characteristics that are associated with persistence. There were relatively detailed demographic descriptions of persisters and dropout-prone students which indicated the influence of academic performance, employment and educational finances, residential patterns, and attitudes, including expectations and motivation.

Academic performance had been found to yield consequential yet perplexing findings relative to persistence. Astin (1975) stated that "by far the greatest predictive factor (relative to persistence) is the student's past academic record and academic ability" (p. 45). Specifically, when controlling for other predictors, more students than expected were persisters if their grade point averages were above 2.25, and more students than expected dropped out if their averages fell below this.

Sex differences have been found to be intervening factors when considering the impact of academic variables: Grade performance was the greatest predictor of dropping out among men, whereas women dropped out for non-academic reasons, such as lack of commitment to their specific college, much more frequently than for strictly academic reasons (Spady, 1971).

While the evidence did, on the average, point to lower performance among nonpersisters, the majority of students who dropped out did so voluntarily. While performance correlated with persistence, it alone accounted for a very small proportion of those students who dropped out. Several studies had, in fact, found a curvilinear relationship between performance and dropping out; i.e., that most withdrawals occurred among either weak or particularly good students. In the first case, inadequate performance would logically result in dismissal. In the latter, students with above-average ability took advantage of their achievement to change institutions for various reasons (NCES, 1977).

Population

The most commonly studied population in attrition/retention research has been entering freshmen; studies that have considered multiple colleges include Hannah (1969), Hackman and Dysinger (1970), Kamens (1971), Nelson (1966), and Panos and Astin (1968). Astin (1977), Sewell and Shah (1967), and Trent and Ruyle (1965) all designed studies to involve senior high school students with a later follow-up at multiple colleges. Sewell and Shah's (1982) work investigated Wisconsin high school students, at different levels of intelligence, planning to enter a degree-granting college. Astin's population included freshmen nationwide at institutions representing the northern, southern, eastern, and western states, both public and private, large and

small, and predominantly white but also black colleges. Trent and Ruyle's information concerning college freshmen was based on a sample of 10,000 seniors in high schools throughout the United States pertaining to the selection of a college.

Watkins (1982) developed several propositions on persistence based on a sample of students that deviated from the norm of the most commonly studied population, freshmen. He assessed upper division students at a two-year institution in Pennsylvania. His findings were based on the results of a multiple regression analysis of independent variables of educational background, academic and social integration, and third variables (defined as student characteristics and experiences) versus the dependent variable of persistence. This analysis enabled the researcher to examine the relative contributions of the different sets of independent variables on the variance in persistence.

The results of this study were explained in terms of propositions as detailed by Watkins. His first proposition, "the pattern of continuous or interrupted postsecondary attendance prior to upper-division enrollment will affect the likelihood that a student will persist," was not supported by the research results. That is, enrollment patterns in postsecondary careers prior to upper-division matriculation did not appear to have an effect on persistence. His second and third propositions, "students are

more likely to persist in the upper division when they exhibit normative congruence (acceptable grades and motivation) with the academic environment of the institution in which they are enrolled," and, "students who experience collective affiliation (interactions shared with faculty and other students informally outside of class activities) while enrolled will be more likely to persist than students who do not experience collective affiliation," were both supported by the results.

Watkins' other propositions were concerned with academic and social integration variables and personal characteristics of students and their interaction on persistence. His findings on these "third variables" when academic and social integration entered the picture did not affect persistence to any significant degree. Approximately 70 percent of the students in this study were commuters. The median age of the sample population, which included students with a diversity of educational backgrounds, was 26. Watkins found that academic and social integration were more important to persistence in the sample group than were previous patterns of attendance or certain personal characteristics or experiences while enrolled.

One conclusion that can be drawn from the results of this study is that upper division students have a propensity to persist. Watkins stated that "it appears that the crucial decision for these students occurs before initial ma-

triculation in their program; once a student enrolls, the probability is high that he or she will persist to graduation" (p. 75).

Science-related Population

Although science-related population studies tended to be fewer in number and not as widespread as other population studies, the variables of sex, race, parental income, grades, and academic aspiration were often chosen as areas of investigation in relation to persistence within these disciplines. The following studies represent a few science-related populations.

Persistence in engineering was investigated by Coles (1983) based on the effects of participation in academic support programs. His sample population was taken from the 1979-80 entering freshman class of students in the School of Engineering, North Carolina State University at Raleigh. Students with GPAs of 2.2 or less were selected for this sample.

Coles used a quasi-experimental design to ascertain the effects of participation in a peer tutorial program upon freshman performance and persistence. An analysis was conducted to determine the relationships between selected variables and grade performance and persistence. His findings were that there was no significant difference in the persistence in engineering between tutored and non-tutored students. Higher persistence rates for men over women, and

similar persistence rates for blacks (72.34%) and white (74.18%) were found. The findings suggested that race was not a factor in persistence and consequently supported Astin's (1975) findings of similar persistence rates for blacks and non-blacks. Perseverance in engineering, degree aspirations (high degree) and not being employed showed positive links with persistence. There were no clear links between financial factors and other socioeconomic status (SES) data and persistence. Coles established from this study that academic performance in the first year of engineering studies in relation to retention was critical.

Ott (1978) reported on retention rates of a sample of 1,637 men and 1,276 women entering freshman engineering students at 16 institutions after they were enrolled for one and one-half years. Distinguishing characteristics of men and women persisters were analyzed, and destinations of non-persisters studied. Results showed higher retention rates for men than for women. Based on survey results, the following conclusions were reached:

1. High school academic achievement as well as post-secondary expectations, motivation, and parental attitudes toward college attendance were related to retention rates for both men and women.
2. Self confidence, graduation from a public high school, and high school mathematics being a favor-

ite subject were related to retention rates for men.

3. Father's highest degree, race, two or more hours of homework per day in high school, plans for marriage, children, and part-time vs. full-time work were related to retention rates for women.

Of those who did not persist in engineering, 43 percent of the men and 68 percent of the women were transfers to other disciplines in the same institution.

The results of another study on the academic and career characteristics of freshman engineering students pointed out that considerable similarities existed between male and female engineering students who persisted in college (Greenfield, Holloway, and Remus, 1982). Their study examined: (a) academic background, including current and historical academic achievement; (b) expectations for first semester in college, that is, the expectation that they would gain a better understanding of engineering; (c) willingness to spend time on academic study; (d) high educational aspirations; (e) desire for opportunities that included problem solving and challenging work; (f) availability of engineer role models in the family; (g) perceived support from family, friends, and teachers for pursuit of a career in engineering; (h) perception of their own personal characteristics of striving for good grades and friendly, but neither shy nor artistic; and (i) congruence between image of self

and image of an engineer (p. 51). Of the 322 males and 42 females in their study, at the end of the freshman year, 87.7% (320 of 364) of the students remained in engineering, while 7.7% (28 of 364) had transferred to another college, and 4.6% (16 of 364) were dropped due to poor academic performance. The persistence rate for males was 81%, for females 40%. Because this study was considered exploratory, the responses to the questionnaire were analyzed using descriptive statistics rather than inferential statistical tests; therefore, the result should be understood from that perspective.

College "Fit" and Commitment

While much research has examined student characteristics and persistence, there has also been considerable interest in the interaction of student characteristics in an environmental context. This interaction has been termed the "congruence" or "fit" between the student's needs, interests, and abilities, and the unique set of demands, constraints, and rewards of a given college environment (Feldman and Newcomb, 1969; Smith, 1976).

The college "fit" notion was a phenomenological interpretation of the student and the institutional environment as he or she perceives it. Students had been found to persist if they did not experience discrepancies between "perceptions of the self and of the college, of the self and [other] students, and the college and the ideal college"

(Pervin and Rubin, 1967, p. 289). These discrepancies can result in low satisfaction in most college settings or stress in highly regimented institutional environments (Rootman, 1972; Starr, Betz, and Menne, 1972). Pantages and Creedon emphasized the "college fit" or congruency theory: "The degree to which the attitude and values of the student correspond with those of the institution is also the degree to which the student is likely to persist at the institution" (1978, p. 80). They noted that students had different motivations for attending different types of institutions, which in turn suggested that different institutions attract students with different personality characteristics (1978, p. 80). If for some reason a student's expectations were not satisfied once enrolled, then cognitive dissonance took place; that is, respondents began to alter their concepts to coincide with their decisions, or attrition occurred.

Taylor and Whetstone (1983) examined the differences in personal characteristics between high- and low-achieving engineering students at the University of Colorado at Boulder and their counterparts in the College of Arts and Sciences and the Air Force Academy. The sample consisted of full-time male and female students who had completed at least one year of college at each institution. High achieving students were those whose GPA was 3.5 or above. Students with GPAs of 2.25 or less were classified as low-achieving.

The researcher hypothesized that if the college-fit theory was accurate, then personal values, attitudes, and goals of academically successful students should be different from those of unsuccessful students within the college and from those of successful students in other colleges. Therefore, students who persisted and were academically successful would have characteristics congruent with the college they attended, reflecting the values, goals, and attitudes most esteemed by that college. Conversely, engineering students who were minimally successful in academics would not be as congruent with the values, goals, and attitudes of the engineering college. Using one-way analysis of variance with Duncan's Multiple Range test to calculate frequencies, t values, means, and standard deviations for each group, significant differences were observed between groups on the several scales of the Colorado Educational Interest Indicator, an educational interest inventory. It was found that high-achieving men engineering students had significantly higher scores than low-achieving men engineering students on the analytical, industrious, organized, and scholarly personal characteristics. The concept of the college-fit theory appeared to be substantiated by the results of the study. This suggested that identifiable personal characteristics of successful engineering students can be described and used to assist students in selecting the college setting where they would best fit.

Academic Integration

Grades, which are intrinsic, immediate rewards, also affect extrinsic future educational and career mobility options. Tinto (1975) suggested that grade performance is ". . . both a reflection of the person's ability and of the institution's preferences for particular styles of academic behavior" (p. 104). The importance of grade performance in fostering persistence was related to pressures for future occupational development, particularly in men (Spady, 1970).

The notion of "sense of competence" explained another way in which grades were translated into normative standards for the individual. "A sense of competence is developed through interaction with others and is essentially the level of productivity and effectiveness an individual feels he or she has when performing intellectual, interpersonal, or physical tasks" (South, 1975, p. 45). It is "fostered first by the examples set by the persons who are in contact with the developing individual, second, by the demands they make, and third, by the encouragement they extend" (South, 1975, p. 45). Grades are an objective standard against which the individual student can evaluate his or her sense of competence which was established in interaction with others.

Sense of competence is a unifying concept that brings together the notions of academic (normative) integration and social integration (collective affiliation). To understand the process by which this occurs, it is instructive to

examine the group and interpersonal process that affects students. Central to each student's academic and social integration into the campus are the reference groups with which he or she identifies. Sherif and Sherif (1964) explained that a reference group is "the group with which the individual identifies or aspires to belong" (p. 55). Reference groups are established in large part because they provide tangible or psychological support to members. They also arise out of interactions that are formally structured, e.g. among students in academic departments or fields of study.

Attrition

Attrition has been a problem which has been studied and reported in great detail for many years. It has been a problem that has affected not only the future growth of an institution but also the current levels of funding that supported academic programs, housing occupancy, faculty/student ratios, and general student services. As population shifts occurred in the troubled industrial areas of the country, the potential enrollment problems facing colleges and universities intensified. Some researchers have conducted extensive studies that have focused on attrition as a phenomenon that is multifaceted and affected by current trends in society.

Astin defined dropouts as students who, after four years, were neither stopouts (temporary dropouts) nor per-

sisters (1975, pp. 9-10). To Astin, a dropout was any student who, after four years, was not enrolled in graduate or professional school, did not have a bachelor's or higher degree, was not currently enrolled full-time as an undergraduate, and/or was no longer pursuing a degree. He eliminated those students whose initial aspirations did not include attainment of a degree.

Tinto noted the failure of some researchers to distinguish the dropouts resulting from academic failure from those resulting from voluntary withdrawal, and suggested that this lack of separation has resulted in at least some of the conflicting results (1975, p. 89). He suggested that findings which indicate academic ability to be inversely related to dropout, unrelated to dropout, and directly related to dropout are typical examples of such conflicting results (1975, p. 90). On the other hand, Pantages and Creedon (1978) suggested that making a distinction between voluntary and non-voluntary withdrawal (academic dismissal) was not appropriate because such a distinction tended to ignore the factors which caused poor academic performance in the first place. They claimed that it was these other factors that actually influenced the decision to drop out, not the poor grades resulting from these factors (p. 52).

Persistence

Astin (1975) developed an operational definition of the term "persistence." He suggested that persisters were those

students who had successfully completed or were actively pursuing a baccalaureate degree at the time of the study.

Spady (1970) explained persistence as being problematic, rather than given. It is derived from the interaction of the student and the college "press" or environment, in which the student's interests, skills, attitudes, and dispositions were exposed to a variety of influences from faculty, peers, and courses. To the extent that the student's attributes and predispositions were congruent with the prevailing academic and social climates of the institution, and the student received sufficient extrinsic and intrinsic rewards from participating, the student would be socially integrated into the institution. The student would persist, according to Spady, if social integration resulted in satisfaction and hence in college completion.

Tinto's model, which has been the focus of considerable research over the past decade, has brought theoretical direction to an area of inquiry sorely in need of focus. Studies of short-term persistence at a single institution and longitudinal type studies at multiple institutions have been utilized to test the model created by Tinto (Bean, 1980; Pascarella & Chapman, 1983; and Pascarella & Terenzini, 1983). One study (Pascarella, Smart, & Ethington, 1986) employed Tinto's theoretical model to explain the long-term persistence of students who began their postsecondary education in two-year institutions. As the findings in

Watkins' (1982) study of upper-division students supported the proposition that students are likely to persist in the upper division when they exhibit normative congruence (acceptable grades and motivation) with the academic environment, so then do the findings of Pascarella, Smart and Ethington (1986) underscore the concept of person-environment fit as an important determinant of persistence in postsecondary education. Furthermore, the findings suggested that what happens to a student after he or she enrolls at an institution may be as important to ultimate persistence of postsecondary education as the influence of pre-college variables. Therefore, it may be possible to enhance student persistence in postsecondary education through purposeful institutional policies and practices designed to enhance student social and academic integration. Consistent with the findings of Pascarella and Terenzini (1983), the results of Pascarella, Smith and Ethington's study suggested significant differences in the factors influencing persistence for men and for women.

The data for their study were drawn from the 1971-1980 Cooperative Institutional Research Program (CIRP) surveys. The model was estimated on a national sample of 825 students who initially enrolled in 85 two-year institutions in the fall of 1971. The sample was followed for nine years.

The recent trend in research on persistence of students has been to expand the literature in terms of special popu-

lations such as students from two-year institutions, students pursuing particular careers or majors, and those who would perhaps persist to graduate school. The factors that have influenced persistence continue to be multifaceted and dependent upon student and institutional characteristics. Studies have followed students in one institution for a short period or have looked at a long-term process at multiple institutions. One important aspect, however, has been the need for expansion of the literature in order to continue to provide answers to policy concerns and implementations.

Summary

This chapter has reviewed the literature pertaining to persistence and student characteristics and has explored the concept of college "fit" as it related to the academic disciplines of science and technology. Persistence has been found to be the result of the "fit" between a student and the particular academic and social environments of the college in which he or she is enrolled. As the population of entering freshmen became more diversified, identifying characteristics, attributes, and commitments that led to persistence in popular academic fields became an important element in the development of perceptions of students, colleges, and disciplines. As the literature suggested, freshmen were the most commonly studied population; the sample population used for the present study was taken from a group

of students who were classified as juniors. According to Feldman and Newcomb (1969):

> "During the undergraduate years, students devote considerable attention to matters of post-college interests and careers in general, they become more definite about their vocational and educational aspirations and expectations. Normally, persons who are initially undecided about the field in which to major make a decision during the early years of college" (p. 36).

It is for these reasons that a study that investigates the characteristics of students in the science and technology disciplines should look at those who are at junior or higher status. A variety of statistical analyses have been used throughout the literature to test or predict persistence. Astin (1975) used multiple regression; Sewell and Shah (1967) and Pascarella and Terenzini (1978) used discriminant analysis. Some studies were based on single institutions and science related disciplines (Watkins, 1982; Ott, 1978), while others explored student characteristics using multiple institutions (Astin, 1975; Sewell and Shah, 1967; Fetters, 1977). Tinto's theory suggested that persistence is a multifaceted phenomenon. The present study utilized that theory by collecting information regarding demographic characteristics, environmental characteristics, and social

and academic integration factors as measured by Pascarella and Terenzini (1979).

This research examined persistence in the fields of science and technology, the rationale being that "commitments," as seen by Tinto, would be stronger in a population in which academic integration was considered to be a priority for continued enrollment. With the competitive job market and with the move towards material concern -- 71.2 percent of freshmen nationwide indicated that "being well off financially" was very important (Astin, 1984) -- it has become very popular and attractive to obtain a degree in science and technology. Pantages and Creedon (1978) found that students who experienced congruence with academic norms and goal commitments were more likely to persist, hence the need to further investigate this claim with a population entrenched in the disciplines of science and technology.

Through the process of identifying and classifying the characteristics of those students who have achieved upper division status in the fields of science and technology, a variety of data must be collected. Perhaps the results could then be used to create a model which would distinguish persisters from nonpersisters, which in turn could be used as a self-screening tool by prospective career seekers in the science and technology fields. This tool should be viewed as no more than a step toward good decision making in terms of reaching a career or vocational objective.

CHAPTER THREE

RESEARCH METHODOLOGY AND DESIGN

The purpose of this study was to identify student characteristics and college environments that contribute to or hinder persistence among students in scientific and technological disciplines. Survey research design was used to collect data on student characteristics and environmental factors that traditionally affect persistence among college students. The approach was to investigate two groups of students: persisters (those who remained in science and technology) and nonpersisters (those who changed from science and technology), to assess what characteristics or variables were common or different between the groups, and then to determine whether the differences seemed significantly to affect persistence in the fields of science and technology.

Based on Tinto's (1975) theory, a questionnaire was developed to collect information on student and environmental characteristics. A pilot study with 25 students was conducted to test the questionnaire. A final form of the questionnaire was then selected and administered to the sample population.

Selection of the Sample

The target population consisted of 515 students from the University of California, San Diego's four colleges who, as freshmen, had declared majors in six disciplines and who had advanced to junior status. The six disciplines were

Biology, Chemistry, Applied Mechanics and Engineering Sciences, Electrical Engineering and Computer Sciences, Mathematics, and Physics. The population was divided into two groups. One group consisted of students who entered as freshmen in Fall 1982 and who remained through Spring 1985 in the same or a related science or technology major; this group was coded as persisters. The second group was composed of students who also entered as freshmen in 1982 and were subsequently (Spring 1985) enrolled, but who had changed to a major outside of the science and technology area; this group was coded as nonpersisters.

Data collected from the UCSD Registrar's Office indicated that 928 students of junior status were majoring in the six science/technology disciplines through Spring 1985. By matching a list of freshmen who entered in Fall 1982, with intended majors in the six science/technology disciplines, with a list of juniors enrolled Spring 1985 with declared majors in the six science/technology disciplines, it was determined that 322 persisted from Fall 1982 to Spring 1985 within their disciplines, while 193 had changed their majors to one outside of the six listed. The remaining number of juniors were presumed to be students who transferred in after 1982, who entered before 1982 and have taken more than two years to reach junior status, or who were undecided majors when they entered as freshmen.

Surveys and questionnaires were mailed to 50 percent of the total eligible students (515). It should be noted that only 254, not quite 50 percent of 515, were actually mailed the surveys and questionnaires because of a discrepancy in four names that were listed in more than one college. The breakdown of the total eligible students, persisters and nonpersisters, by college and sex is shown in Table 2.

Table 2

Distribution of Sample Population by College, Sex, and Persistence

College	%	Sex		Total
		M	F	
Persisters				
Revelle	37	70	48	118
Muir	23	46	30	76
Third	18	35	23	58
Warren	22	42	28	70
				322
Nonpersisters				
Revelle	21	19	22	41
Muir	23	24	20	44
Third	30	25	33	58
Warren	26	30	20	50
				193
			Total	515

The following table (Table 3) shows the breakdown by college

and sex of the students who were mailed the survey and questionnaire.

Table 3

Distribution of Survey Population by College, Sex, and Persistence

College	Sex		Total
	M	F	
Persisters			
Revelle	35	24	59
Muir	23	15	38
Third	18	12	30
Warren	21	14	35
			162
Nonpersisters			
Revelle	10	11	21
Muir	12	11	23
Third	13	10	23
Warren	15	10	25
			92
	Total		254

Table 4 shows the number of subjects who only returned surveys and questionnaires.

A look at Table 4 will show that the number of subjects who returned surveys and questionnaires varied by college. A closer look will show that the largest number was returned by Revelle persisters. Surveys and questionnaires were returned in greater number by persisters than by nonpersisters.

Table 4

Breakdown of Subjects who Returned Survey and Questionnaire by Persistence, College and Sex

College	Persisters		Total
	Male	Female	
Revelle	14	6	20
Muir	6	7	13
Third	7	7	14
Warren	2	8	10
TOTAL	32	25	57
	Nonpersisters		
Revelle	2	8	10
Muir	5	6	11
Third	5	6	11
Warren	8	2	10
TOTAL	20	22	42
			N = 99

In order to obtain a proportionate number of subjects based on college, sex, and persistence, the final number of subjects matched by college and sex were 40 persisters and 40 nonpersisters. These subjects completed the survey, the questionnaire, and the Strong-Campbell Interest Inventory.

Table 5

Breakdown of Final Group of Subjects by College and Sex

College	Male	Female	Total
	Persisters		
Revelle	8	2	10
Muir	3	7	10
Third	6	4	10
Warren	5	5	10
TOTAL	22	18	40
	Nonpersisters		
Revelle	2	8	10
Muir	4	6	10
Third	4	6	10
Warren	8	2	10
TOTAL	18	22	40
			N = 80

Table 5 shows the number of subjects by persistence and sex who returned both the survey and questionnaire and took the Strong-Campbell Interest Inventory.

Procedures

The general research procedure involved the administration of a researcher-designed questionnaire, along with the Pascarella and Terenzini survey and the Strong-Campbell Interest Inventory (SCII) to two samples of students. One group (persisters, 162) was composed of subjects who were consistently enrolled and majoring in a field of science and technology from Fall 1982 to Spring 1985, while the other (nonpersisters, 92) consisted of subjects who initially

(Fall 1982) selected a field of science and technology as an intended major, were consistently enrolled at the university, but ultimately (Spring 1985) had changed to a major outside of those disciplines.

During the month of October 1985, each of the 254 students was mailed a survey and questionnaire and asked to return the information in a stamped, self-addressed envelope. Three weeks after the initial mailing, a phone call follow-up was made by a student worker. During the fourth week, a reminder postcard was sent out, again requesting that the information be returned within a week. These techniques were used as a means of increasing the response rate.

The cover letter that accompanied the survey and questionnaire explained the purpose of the inquiry, how the subject was chosen, and a request for participation. In addition, the letter informed students of several testing sessions which were scheduled during the month of November for which they were asked to sign up, and also asked them to return the information with the survey and questionnaire.

During the sessions, the SCII was administered to the group or to an individual. Students were instructed to first complete the test, then enter into a brief discussion, as a group, of the following three questions.

1. Do you believe that you can distinguish science/-technology students by colleges?

2. Share with me some of your hobbies and interests that you feel have helped you in your academic endeavors.
3. Name some of the things that you have done while here at UCSD that have confirmed your career choice.

The first two sessions were taped. There were enough participants in these sessions that the variety of males and females and college representatives provided sufficient feedback that could be analyzed by a trained professional. After the first two sessions, taping was discontinued because students were seen individually rather than in a group; in addition, due to the differences in the length of time it took for each individual to complete the SCII, it was more effective to speak individually to each subject. Results from these discussions will be presented in Chapter 4, Analysis of Data.

Instruments

Questionnaire. The questionnaire, mailed to a sample group of 254 students, contained 23 questions. Designed by the author, this instrument was intended to elicit a variety of background experiences suggested by the research literature that relate to persistence. The questionnaire consisted of eight open-ended questions concerning career choices, college choice, and factors pertaining to persistence or non-persistence in a major (Appendix B). Based on student

persistence research, the following items were chosen for inclusion in the researcher-designed questionnaire: There were three Likert-type items, three requiring answers utilizing a rating scale (e.g. 1-99), six yes-no items, and three multiple choice items relating to parental educational and economic status. The questionnaire was also designed to elicit background data as to sex, ethnicity, age, GPA, major, and college of registration. The reliability and validity of the questionnaire was tested during the pilot study phase of the study. The discussion of the validity and reliability can be found in the pilot study section in this chapter.

Survey (Pascarella and Terenzini). This instrument is a 34-item, five response Likert survey (Appendix B). The instrument is divided into five sections: I Peer-Group Interaction; II Interaction with Faculty; III Faculty Concern for Student Development and Teaching; IV Academic and Intellectual Development; and V Institutional and Goal Commitments. A score is derived for each section based on the number of items per section and the total of the ratings. An average score for each section is then calculated. All 254 students received this survey.

This survey had been used by Pascarella and Terenzini (1980) to predict freshman persistence. In their study of freshmen at a large, northeastern university, statistical analysis resulted in the following data. The alpha relia-

bilities of the scales ranged from .71 to .84 and were judged adequate for using the scales in further analysis.

The correlations among the five scales were quite modest, ranging from .01 to .33 with a median correlation of .23. Thus the scales would appear to be assessing dimensions of institutional integration that are substantially independent of one another.

The five institutional integration scales developed for their investigation increased identification of persistence and dropouts in a cross-validation sample from 58.2 percent to 81.4 percent and from 34.5 percent to 75.8 percent, respectively. Scores on the five scales alone correctly identified 78.9 percent of the cross-validation persisters and 75.8 percent of the students in the cross-validation sample who later dropped out. The results generally support the prediction validity of the major dimensions of the Tinto model.

Strong-Campbell Interest Inventory. The SCII is a vocational interest inventory that has the longest history of any psychological test in widespread use today (Campbell and Hansen, 1980). It is used chiefly as an aid in making curricular or occupational choices in planning career options. This test was administered to the eighty students who returned the questionnaire and survey. It was generally done in group sessions of 3 to 15 students at a time.

The SCII is scored on six general occupational themes, 23 basic interest scales, an academic comfort scale, an introversion-extroversion scale, and several administrative indices. Every occupation is represented by a national sample, and the characteristics of the criterion samples were studied carefully to ensure that they were representative of their respective occupations. This test measures interests, not aptitude or intelligence.

There is a long history of research on the predictive validity of the SCII (Strong, 1930). Strong believed intensely in the value of empirical data, and very early he began collecting longitudinal data to use in studying the practical usefulness of his inventory.

Following Strong's predilection, a number of other investigators have conducted studies of validity of the inventory over long time periods. The basic finding of these studies is that there is a substantial relationship between high scores on the occupational scales and eventual occupation entered. Campbell (1966) showed that predictability is higher for students who have well-defined interest patterns, an outcome that also appeared in Strong's 18-year follow-up of Stanford University students. A study by Spokane (1979) examined the predictive validity of the SCII for college women and men over a three and one-half year span. Excellent predictive validity was found for 42.5 percent of the females and 59.3 percent of the males.

The statistics available on the test-retest factor of the SCII have demonstrated the high reliability factor of this instrument. The most recent statistics (Campbell, 1981) were derived from samples tested and retested over two-week, thirty-day, and three-year periods.

Pilot Study. The questionnaire was pilot tested with a group of 25 student leaders at UCSD during the Fall 1984 Leadership Training Program, and again during the first week of Spring quarter 1985. The overall results from the questionnaire were consistent with the first administration. Since there was no score that was determined from the questionnaire, the validity and reliability was determined by comparing the two administrations of the instruments and the composite results. It was found that the subjects on both occasions answered all the questions. Adjustments in the number of spaces needed for responses were made following the initial administration. In addition, suggestions made as to format and type size were incorporated into the final draft. The answers on the second administration were similar to those on the first administration. It was not necessary to verify background information because it was again consistently recorded. There was a tendency on the part of the subjects to give more details than were called for, but that was because of their familiarity with the researcher and the project. It should be noted that the pilot sample

consisted of students involved with the student leadership program at Revelle College.

Statistical Analysis and Hypotheses

Quantitative Data. The purpose of the study was to determine the effects of student and environmental characteristics on persistence of undergraduates in science and technological disciplines. The statistical procedure of discriminant analysis was chosen because it is generally used to describe the strength of relationship between several independent variables and one dependent variable. In this study the dependent variable is persistence, as determined by staying in the major, while the independent variables are sex, college affiliation, parental income, parental educational background, and the scores from the Pascarella and Terenzini survey. In addition, chi-square goodness of fit tests were also chosen to analyze the frequency of occurrence within the groups of persisters and nonpersisters on two factors, academic comfort and science related interests, as derived from the SCII.

The Bio-Medical Data Program (BMDP), a set of computer programs, was selected for the data analysis because of its simple but unique capability for handling a variety of data files.

The following null hypotheses were tested:

Demographic considerations:

1. There is no significant difference between students who persist in science/technology majors versus nonpersisters attributable to college affiliation.
2. There is no significant difference between persisters and nonpersisters attributable to sex.
3. There is no significant difference between persisters and nonpersisters attributable to sex and college choice combined.
4. There is no significant difference between persisters and nonpersisters attributable to grade point average (GPA).
5. There is no significant difference between persisters and nonpersisters attributable to parental income.
6. There is no significant difference between persisters and nonpersisters attributable to parental educational background.

Environmental considerations:

7. There is no significant difference between persisters and nonpersisters based on these factors: Peer group interactions, interactions with faculty, faculty concern for student development and teaching, academic and intellectual development, and institutional and goal commitments.

a. There is no significant difference between persisters and nonpersisters based on peer-group interactions alone.

b. There is no significant difference between persisters and nonpersisters based on interactions with faculty alone.

c. There is no significant difference between persisters and nonpersisters based on faculty concern for student development and teaching alone.

d. There is no significant difference between persisters and nonpersisters based on academic and intellectual development alone.

e. There is no significant difference between persisters and nonpersisters based on institutional and goal commitments alone.

Student interest considerations (as measured by SCII):

8. Persistence is independent of academic comfort.

9. Persistence is independent of science-related interests (identified by Holland 3-letter code).

Qualitative Data

Data collected from the questionnaire and from individual and group discussions conducted during administration of the SCII were used to identify further the characteristics of the groups of persisters and nonpersisters. A set of descriptive analyses such as frequencies of occurrences

was used to explain the results from these questions and discussions.

The information gathered from the questionnaire and the interview provided a series of responses that were indicative of conditions that are descriptive of persisters and nonpersisters.

CHAPTER FOUR

DATA ANALYSIS AND RESULTS

The purpose of this study was to determine the effects of student characteristics (sex, college choice, parental income, GPA), and college environments (academic and social integration factors) on persistence among science and technology majors.

A stratified random sample of 162 persisters and 92 nonpersisters was chosen from the four colleges at UCSD. The Pascarella-Terenzini survey, along with a researcher-designed questionnaire, was mailed to these undergraduates of junior status, who were either currently enrolled in a major in the science/technology field or who had changed from science to a different major. The Strong-Campbell Interest Inventory, a vocational interest inventory, was administered to 80 of the undergraduates who returned questionnaires and were matched by college and sex. Subjects were queried individually and in group sessions. Students were identified by college and sex and grouped as persisters or nonpersisters.

There are some demographic, college environment and student interest considerations that are useful as predictive variables in identifying persisters and nonpersisters in the science and technology fields among junior level college students. Of the variables that were employed to

test this statement, a few emerged as significant predictors of persistence. The results are presented for each factor (demographic, college environment and student interest), as these characteristics relate to specific questions asked.

Demographic Variables

Hypothesis 1. There is no significant difference between students who persist in science/technology majors versus nonpersisters attributable to college affiliation as determined by official listing of records from the UCSD registrar's office.

Official lists from the UCSD registrar's office were used to determine the number of students who had indicated a major in a science/technology field and their college affiliation. Additional information was also collected from the researcher-designed questionnaire and then verified by these official lists.

Of the 162 persisters surveyed, Revelle College had the highest number, with 59. Muir College followed with 38, while Warren College had 35. Third College had the lowest number, with 30 students. In respect to the number of nonpersisters, 92, Warren had the highest, with 25. Muir and Third each had 23, while Revelle had the lowest, with 21.

Using this data, a chi-square analysis was conducted to ascertain whether there were differences based on college affiliation. Table 6 shows the distribution as well as the results of this analysis.

Table 6

Distribution of Subjects by College Affiliation

	Revelle	Muir	Third	Warren	Total
Persisters	59	38	30	35	162
Nonpersisters	21	23	23	25	92
Total	80	61	53	60	n = 254

X^2 = 5.46 df = 3

The results indicated that there were no significant differences between persisters and nonpersisters based on college affiliation. The null hypothesis regarding college affiliation was therefore retained.

The college system at UCSD allows students interested in science and technology majors at UCSD to enroll in any of the four colleges. The differences in the college system lie within the general educational requirements of each college; therefore, students are attracted to each for the general education structure or lack thereof.

Hypothesis 2. There is no significant difference between persisters and nonpersisters attributable to sex, as determined from official lists from the UCSD registrar's office.

Data were collected from the researcher-designed questionnaire as well as from the lists from the UCSD regis-

trar's office. As reflected by the total number of persisters, it can be determined that 59% were male and 41% were female. In the category of nonpersisters the male/female distribution was a little closer, with 54% male and 46% female.

The data were tested by using a chi-square analysis. The results can be seen in Table 7.

Table 7

Distribution of Subjects by Gender

	Male	Female	Total
Persisters	97 (59%)	65 (41%)	162
Nonpersisters	50 (54%)	42 (46%)	92
Total	147	107	n = 254

x^2 = .74 df = 1

The results indicated that there were no significant differences between persisters and nonpersisters with respect to gender. The null hypothesis regarding gender was retained. The results from this analysis are indicative of the male/female ratio that exists within the overall UCSD population. Traditionally, the science and technology majors have been male dominated for many years.

Hypothesis 3. There is no significant difference between persisters and nonpersisters attributable to sex and college combined, as determined by the official list from the UCSD registrar's office and the researcher-designed questionnaire.

The data were collected from official lists as obtained from the UCSD registrar's office and from the demographic data on the researcher-designed questionnaire. Table 8 shows a breakdown of students both by college affiliation and by sex. The data were tested by using a chi-square analysis of these two factors combined.

Table 8

Distribution of Subjects by College Affiliation and Gender Combined

		Revelle	Muir	Third	Warren	Total
Persisters	m	35	23	18	21	97
	f	24	15	12	14	65
Nonpersisters	m	10	12	13	15	50
	f	11	11	10	10	42
						n = 254

χ^2 = 6.20 df = 3

The chi-square analysis was conducted using the male

group and the female group at each college and then combining the factors of college affiliation and gender.

The results indicate there were no significant differences between persisters and nonpersisters with the factors of college affiliation and gender combined. The null was therefore retained based on these results.

> Hypothesis 4. There is no significant difference between persisters and nonpersisters attributable to grade point average (GPA) as measured by the researcher-designed questionnaire's demographic data.

Participants were asked to report their cumulative GPA as part of one of the items on the questionnaire. The average GPA for persisters was 3.16, while for nonpersisters it was 2.89. For male persisters the average GPA was 3.09, and for male nonpersisters it was 2.89. For female persisters the average was 3.24, while for nonpersisters the average was 2.91. Male nonpersisters had the lowest average GPA. The scores that are shown in Table 9 are scores of the subjects who completed surveys, questionnaires, and the Strong-Campbell Interest Inventory.

It should be noted that hypotheses 4 through 9 were tested based on the results of the final sample population, 80 subjects. This number represents the number of subjects who completed all three instruments (the survey, the questionnaire, and the Strong-Campbell Interest Inventory). The

data were complete for all 80 subjects on the factors of GPA, parental income, parental educational background, Pascarella and Terenzini Scales, academic comfort scale of Strong-Campbell interest inventory, and the science related interest scales of the Strong-Campbell Interest Inventory, and therefore it was necessary to be consistent and only include those subjects who had responses for all three instruments.

Table 9

GPA Means for Persisters and Nonpersisters

	Persisters	Nonpersisters
Male	3.09	2.88
Female	3.24	2.91
Average	3.16	2.89
		n = 80

In Table 10 the results of an ANOVA which was performed on the GPA data is given. The results indicate that persisters' GPA (3.16) was significantly higher than nonpersisters (2.89), $F(1,76) = 8.25$, $p < .01$. The null hypothesis regarding GPA was therefore rejected.

Table 10

Analysis of Variance on GPA, Factored by Persistence and Sex

Source	SS	df	F	Tail Prob.
Mean	720.84920	1	4271.89	0.00
Perst	1.39152	1	8.25	0.01 *
Sex	0.16052	1	0.95	0.33
PS	0.06309	1	0.37	0.54
Error	12.65570	76		
				n = 80

* $p < .01$

The significance of this finding supports similar findings in several studies conducted in past years that have shown grades, when viewed as a reflection of a person's ability and an institution's preference for a particular style of academic behavior, are good predictors of persistence (Spady, 1970; Tinto, 1975; Watkins, 1982).

Hypothesis 5. There is no significant difference between persisters and nonpersisters attributable to parental income as determined from the researcher-designed questionnaire, item number 1 (Appendix B).

The data were collected from the 80 subjects by means of the student questionnaire, which contained information on

several demographic variables. Students were asked to report their parents' combined income by using a five-category measure. These categories were $0-20,000, $20,000-40,000, $40,000-$60,000, $60,000-80,000, and Above $80,000.

A grouped frequency distribution of parental income level by persister type is shown in Table 11. Inspection of the columns' marginal sums indicate that 28 (35%) of the total responses were for incomes of $40,000 or below, while 52 (65%) were for incomes above $40,000. Inspection of the cells within the table indicates that a larger percentage of parental income levels above $40,000 is consistent across the persister-type groups. That is, 27 of 40 persisters reported parental income levels about $40,000. The number of subjects whose parents earned $40,000 or less is 13 (16.25%) and 15 (18.75%) for the persister and non-persister groups, respectively.

In Table 12, the frequency of responses for income across $0-20,000 were collapsed and summed due to the low frequency in the $0-20,000 cells. The same procedure was performed for each group for similar reasons. The resulting chi-square analysis indicates that there are no significant differences between persisters and nonpersisters based on parental income. The null hypothesis was retained.

Table 11

Frequency of Parents' Income Level by Persistence Group

	Thousands				
	0-20	21-40	41-60	61-80	81+
Persisters	3 (3.8%)	10 (12.5%)	12 (15%)	9 (11.2%)	6 (7.5%)
Nonpersisters	3 (3.8%)	12 (15%)	9 (11.2%)	7 (8.7%)	9(11.2%)
Total	6 (7.5%)	22 (27.5%)	21 (26%)	16 (20%)	15 (19%)
					n = 80

Table 12

Grouped Frequency of Parents' Income Level by Persistence Group

Thousands	Persisters	Nonpersisters	Total
0 - 40	13	15	28
41 - 81	27	25	52
	40	40	n = 80

x^2 = .22 df = 1

Eligibility for admission to the undergraduate campuses of the University of California is dependent upon high SAT scores and high school GPA. Students who attend these institutions come from the top 12% of their high school

class. What some studies have shown is that there is a high correlation between high SAT scores and parental income level. The results from this study show that more students, regardless of persister type, were from homes where parents earned $40,000 or more.

Hypothesis 6. There is no significant difference between persisters and nonpersisters attributable to parental educational background as determined from researcher-designed questionnaire item #2.

Subjects were asked to indicate the highest degree completed by each parent. They were given a choice of None, BA/BS, MA/MS, Ph.D, and Professional.

Table 13 presents the outcome of subject responses to parental educational background. The subjects' responses indicate that mothers without a degree totaled 33 (41.25%), which is greater than fathers without a degree, 21 (26.25%). Further inspection of the cells within the table indicates that the number of mothers without a degree is 16 (40%) for persisters and 17 (42.5%) for nonpersisters. The data were similar for fathers (i.e., persisters had fewer fathers without degree than did nonpersisters). The results indicate that there was no significant difference between persisters and nonpersisters in regards to parental educational background.

Table 13

Distribution of Gender and Subject Persistence Group by Parental Educational Background

Type	Degree				
	none	BA	MA/MS	Ph.D.	Prof.
Mothers					
Persisters	16 (40%)	12 (30%)	4 (10%)	2 (5%)	6 (15%)
Nonpersisters	17 (42.5%)	13 (32.5%)	6 (15%)	1 (2.5%)	3 (7.5%)
Total	33 (41.25%)	25 (31.25%)	10 (12.5%)	3 (3.75%)	9 (11.25%)
Fathers					
Persisters	10 (25%)	16 (40%)	8 (20%)	1 (1%)	5 (7.5%)
Nonpersisters	11 (27.5%)	10 (25%)	10 (25%)	5 (12.5%)	4 (10%)
Total	21 (26.25%)	26 (32.5%)	18 (22.5%)	6 (7.5%)	9 (11.25%)

Further inspection of Table 13 indicates that the frequency of sample responses across MA/MS, Ph.D., and Professional groups was too small for chi-square comparisons. A chi-square analysis for mothers' and fathers' educational background was done separately. Tables 14 and 15 show the results of these analyses. The data were separated to try to detect any differences between mothers' education and fathers' education.

Table 14

Results of Chi-Square Analysis on Parental Educational Background Factor -- Mothers

Degree	Persisters	Nonpersisters	Total
None	16	17	33
BA	12	13	25
MA/MS+	12	10	22
Total	40	40	n = 80

χ^2 = .54 df = 2

Table 15

Results of Chi-Square Analysis on Parental Educational Background Factor -- Fathers

Degree	Persisters	Nonpersisters	Total
None	10	11	21
BA	16	10	26
MA/MS+	14	19	33
Total	40	40	n = 80

χ^2 = 2.18 df = 2

When the chi-square analysis was conducted for mothers and fathers separately, the results indicate that there were no significant differences between persisters and nonpersis-

ters with regard to parental educational background. The null hypothesis was therefore retained.

College Environment Variables

Hypothesis 7. There is no significant difference between persisters and nonpersisters based on the factors of peer group interactions, interactions with faculty, faculty concern for student development and teaching, academic and intellectual development, and institutional and goal commitments.

a. There is no significant difference between persisters and nonpersisters based on peer group interactions alone.

b. There is no significant difference between persisters and nonpersisters based on interactions with faculty alone.

c. There is no significant difference between persisters and nonpersisters based on faculty concern for student development and teaching alone.

d. There is no significant difference between persisters and nonpersisters based on academic and institutional development alone.

e. There is no significant difference between persisters and nonpersisters based on institutional and goal commitments alone.

The Pascarella-Terenzini survey was used to collect data to determine the effects of the college and environment factors considered in this study. The first step was to conduct a discriminant analysis, using persistence, defined as staying in a major in the fields of science and technology, as the dependent variable and subjects' responses on five categories from the Pascarella-Terenzini survey and demographic variables of college affiliation, sex, GPA, parental income and parental educational background as independent variables.

The process of discriminant analysis is used to describe the strength of relationship between several independent variables and one dependent variable. The technique involves two or more predictor variables and a single criterion variable. In this study, the criterion variable was persistence. An individual was grouped as being a persister or a non-persister. Using the scores from the Pascarella and Terenzini scale as predictive variables and persistence as the criterion variable, the discriminant equation was then created. The attempt was made to predict which members would fall into the persister and non-persister groups.

The results indicate that these factors do not discriminate enough between persisters and nonpersisters; therefore, a model predictive of persistence was not created. This means that the scores of the persisters and nonpersisters were so similar that they were unable to distinguish

between the groups. One reason for this lack of success might be the small number of subjects used in this study. Another reason might also be that originally, nonpersisters were science and technology majors and that the issues tested by the Pascarella and Terenzini scales are not distinctive enough to class these two groups.

In order to test hypothesis 7, a t-test analysis was conducted to determine whether there were significant differences between persisters and nonpersisters on the college environmental factors, as measured by the scales on the Pascarella-Terenzini survey. When the t-test analysis was conducted on each of the five subscales, however, the results indicated that persisters differed significantly from nonpersisters in two areas: interactions with faculty (INTFAC), and faculty concern for student development and teaching (FACSDT). The average score for each factor across groups and the results of the t-test analysis can be inspected in Table 16.

The scale on the Pascarella-Terenzini survey is a five-point Likert-type scale using the numerical factor of five to denote strong agreement and one, strong disagreement. In the subcategory of faculty concern for student development and teaching, the mean score for persisters was 2.87, and for nonpersisters, 3.07. A look at the instrument used, which can be found in (Appendix B), indicates that the items in this category were worded in such a manner that the lower

score indicates a positive response. This was also true in the category of institutional and goal commitment. Closer inspection of the results indicates that on the factor of institutional and goal commitment (IGC), persisters had a low mean score of 2.75 and nonpersisters, a score of 2.82. When the factor of interaction with faculty (INTFAC) was considered, the differences between the means of persisters and nonpersisters was significant. This indicates that persisters' expression of satisfaction with their interaction with faculty was significantly higher than that of nonpersisters. This is not unusual, given that students who are of junior status and have committed to an academic discipline would perhaps require and share more directly with faculty in their chosen field. Nonpersisters, those who dropped out of the science and technology fields, might be indicating one of their reasons for dropping out of the fields.

Table 16

Mean Scores and Results of t-test on the Pascarella-Terenzini Survey

	Persisters (N=40)	Nonpersisters (N=40)	t
	Means		
PGI	3.25	3.28	- .0535
INTFAC	3.29	3.05	4.285*
FACSDT	2.87	3.07	-3.214*
AID	3.40	3.44	- .714
IGC	2.75	2.82	-1.25
Total	3.12	3.13	- .178

*$p < .05$

With respect to the set of hypotheses pertaining to the predictability of each factor, the following is indicated by the outcome. Persisters and nonpersisters do differ according to their experience in the fields of science and technology; however, the results indicate that significant differences are seen in the ratings of persisters and nonpersisters in how they interact with faculty in a non-classroom situation. In the area of faculty concern for student development and teaching, nonpersisters rated the negative value of faculty responsiveness higher than did persisters,

indicating that faculty appeared to be less responsive to their needs as determined by this subcategory. Therefore, the null hypothesis was rejected for the subscales of interaction with faculty and faculty concern for student development and teaching.

There were no significant differences between persisters and nonpersisters on the remaining subscales of peer group interaction (PGI), academic and intellectual development (AID), and institutional and goal commitment (IGC). There was also no significant difference between persisters and nonpersisters on the overall scale of the Pascarella and Terenzini survey. The null hypothesis was therefore accepted for the overall scale and the subscales of peer group interaction, academic and intellectual development, and institutional and goal commitment.

The population used in this study consisted of juniors who had declared majors within one of the science/technology fields or had subsequently changed from one of these areas to a non-science major. At UCSD, students are assigned to a faculty advisor once they have reached junior status and have declared their majors. Findings from a study by Watkins (1982) of upper division students suggested that although there was a sub-population of students who were highly integrated into the social environment of the campus, the relationship in general between student and institution appears to be individualized. He also indicated that com-

mitments to educational goals are developed and maintained intrinsically and not through social reinforcement. The results here suggest that the groups did not differ significantly on their institutional and goal commitment but that further analyses of individuals within the groups might indicate how commitments are developed.

Student Variables

Hypothesis 8. Persistence is independent of academic comfort.

The Strong-Campbell Interest Inventory measured results. There are several scales that are reported from the results of the SCII. The scores that were reported for the academic comfort scale were used to test the differences between persisters and nonpersisters in this category.

The overall chi-square for the test of this hypothesis was insignificant. Inspection of Table 17 indicates that, contrary to expectation, persisters are not significantly more comfortable in the academic setting that nonpersisters. Indeed, both persisters and nonpersisters are of average comfort in academia, as indicated by the high frequency of subjects falling into the medium category on the academic comfort scale. More than 50% of each group were categorized in this ranking. The hypothesis was therefore accepted.

The low, medium and high scores ranking were derived from the information in the manual concerning academic comfort. Generally, persons scoring below 40 were grouped

in the low category, 41 to 59 was considered medium and above 60 was ranked or high. The higher the score, the more compatible the individual should be with the academic environment or setting. Liberal arts majors with aspirations of graduate training tend to score higher on the academic comfort scale than other students in the same institution.

Table 17

Results of Chi-Square Analysis on the Academic Comfort Scale of SCII

	Low	Med	High	Total
Persisters	6	25	9	40
Nonpersisters	13	21	6	40
				n = 80

χ^2 = 3.527 df = 2

Table 18

Results of t-test Analysis on the Academic Comfort Scale of SCII

Source	df	Mean x-y	t-value
Academic Comfort	78	3.55	1.45
			n = 80

The results of the t-test analysis on the scores of the academic comfort scale were not significant. There was no significant difference between persisters and nonpersisters

with regard to their academic comfort level. The hypothesis was therefore accepted.

Scores on the academic comfort scale are interpreted as the name implies: "as an indication of the degree to which the respondent is comfortable in an academic setting" (Campbell & Hansen, 1981). According to Campbell and Hansen, college and university students who have high scores on this scale will normally be doing well in school and will usually report satisfaction with their educational experience. In contrast, students with low scores will frequently be doing poorly and will usually be thinking of dropping out of school and looking for outside activities. In the case of persisters and nonpersisters in this study, 13 nonpersisters showed low scores, while 6 persisters had similar scores. Given this information, further study would be needed to determine whether these students were considering dropping out of the academic setting. It is not surprising, however, that the number of nonpersisters in the low category was twice the number of persisters.

Hypothesis 9. Persistence is independent of science-related interests.

The results of the SCII are reported in terms of a general occupational theme, a basic interest scale, and occupational scales. Psychological research has shown that vocational interest can be described by six occupational themes.

According to Table 19, the number of subjects whose scores were average or above in the categories of Mathematics, Science, Medical Science, and Medical Service on the Basic Interest Scale of the SCII was higher for persisters (19) than for nonpersisters (16). According to Holland (1973), in the American culture most people can be categorized in terms of six types. They may be characterized by one, or by some combination, of these types. These six types -- realistic, investigative, artistic, social, enterprising, and conventional -- are also reflective of the occupational environment that is dominated by a particular type of person. In the investigative type, those with a strong scientific orientation have a great need to understand the physical world; prefer to work independently; prefer to think through rather than to act out problems; describe themselves as analytical, curious, independent, and reserved; and usually search for occupations in the fields of science and technology. The Holland codes are used as a classification model by vocational counselors when presenting profiles of occupations and environments to those seeking information from the results of the SCII. A closer examination of the results indicates that 35 (43.75%) of the subjects' dominant occupational theme was in the Investigative category, which is consistent for students entering occupations of a generally scientific nature (Table 19).

Table 19

Results of Chi-Square Analysis of Science-Related Interest Codes on SCII

	R	I	A	E	S	C	Total
Persisters	2	19	2	9	5	3	40
Nonpersisters	2	16	6	5	5	6	40
							n = 80

$\underline{X}^2 = 4.40$ $\underline{df} = 5$

Table 20

Results of t-test on Investigative Scales of the Strong-Campbell Interest Inventory

	Means		df	Mean x-y	t-value
	P	NP			
Science	59	48	78	11	7.3*
Math	56	52	78	4	2.8*
Medical Science	56	40	78	7	3.8*
Medical Service	55	45	78	10	5.3*
				n = 80	

* $\underline{p} < .01$

When a closer look was taken on the Investigative Scores of SCII, it was determined that t-test analysis on the scores might be useful. The results indicate a significant difference between persisters and nonpersisters on the four factors of this Investigative Category. Persistence

does seem to be dependent upon science-related interests, as evidenced by the results of the t-test on the Investigative Scales of the SCII (Table 20).

Results from Questionnaire

From the number of items used in the questionnaire to generate information concerning self-confidence and satisfaction, the following three questions provided quantifiable information that is further descriptive of persisters and nonpersisters. These questions were:

12. If you took a retrospective look at your attitude as a freshman, how would you rate your confidence in your ability to persist in the field of science and technology?

13. Rate your satisfaction with your choice of college.

14. Rate your satisfaction with your grades.

An ANOVA was performed for each question, contrasting each persister-type group. Results show that there was a significant difference between persisters and nonpersisters in how they rated their confidence in their ability to persist, $F(1,78) = 5.64$, $p < .02$ (Table 21).

Table 21

ANOVA Summary of "Confidence in the Ability to Persist"

Source	SS	df	Ms	F
Mean	466651.25	1	466651.25	1194.35
Perst	2205.00	1	2205.00	5.64*
Error	30475.75	78	390.71	
				n = 80

* $p < .02$

A two-way ANOVA was then performed to further test the differences between sex and persistence. When the factors of sex and confidence in the ability to persist were entered into a two-way ANOVA, the results indicated that there is a significant difference between male and female persisters and nonpersisters and how they rate their confidence in their ability to persist. As the results seen in Table 22 indicate, $F(1,76) = 5.26$, $p < .02$.

Table 22

ANOVA Table for a 2-Factor Analysis of Variance on "Confidence in the Ability to Persist"

Source	df	Sum of Squares	Mean Square	F-test	p value
Persistence (A)	1	2037.297	2037.297	5.26 *	.0246
Sex (B)	1	152.904	152.904	0.395	
AB	1	891.111	891.111	2.301	
Error	76	29434.506	387.296		
					n = 80

p < .02

As can be seen in Table 23, the average score for female persisters was 83.7, while for female nonpersisters the score was 66.9. The score for male persisters was 79.8, while for male nonpersisters it was 76.3. The overall average score of 76.4, based on a rating of 0 to 99, indicates that both male persisters and male nonpersisters scored above the midpoint in their confidence rating, while for females, only the persisters' score was above the midpoint.

Table 23

Mean Scores on Questionnaire Item 12: "If you took a retrospective look at your attitude as a freshman, how would you rate your confidence in your ability to persist in your major?"

	MEANS		
	Male	Female	Totals
	21	19	40
Persisters	79.762	83.684	81.625
Nonpersisters	18	22	40
	76.333	66.864	71.125
TOTALS	39	41	n = 80
	78.179	74.659	76.375

The results from questions 13 and 14 are shown in Tables 24 and 25, respectively.

Table 24

ANOVA Table for a 2-Factor Analysis of Variance on "Choice of College at UCSD"

Source	df	Sum of Squares	Mean Square	F-test
Persistence (A)	1	169.364	169.364	0.611
Sex (B)	1	831.149	831.149	2.996
AB	1	2.67	2.67	0.01
Error	76	21081.4	277.387	

There was no significant difference between male and female persisters and nonpersisters based on how they rated their satisfaction with their choice of college and also their satisfaction with their grades as indicated from the results of a two-way ANOVA, as seen in Tables 24 and 25.

Table 25

ANOVA Table for a 2-Factor Analysis of Variance on "Satisfaction with Grades"

Source	df	Sum of Squares	Mean Square	F-test
Persistence (A)	1	18.976	18.976	0.032
Sex (B)	1	1255.132	1255.132	2.111
AB	1	906.862	906.862	1.525
Error	76	45194.623	594.666	

Table 26

Mean Scores on Questionnaire Item 13: "Rate Your Satisfaction with Your Choice of College."

	MEANS		
	Male	Female	Totals
	21	19	40
Persisters	80.952	87.053	83.85
Nonpersisters	18	22	40
	77.667	84.5	81.425
TOTALS	39	41	n = 80
	79.436	85.683	82.637

In Table 26 the mean scores are reported for male and female persisters and nonpersisters on questionnaire item 13. As the scores indicate, female persisters' (87.1) and nonpersisters' (84.5) scores were slightly higher than male persisters' (80.9) and nonpersisters' (77.7).

Table 27

Mean Scores on Questionnaire Item 14: "Rate Your Satisfaction with Your Grades."

	MEANS		
	Male	Female	Totals
	21	19	40
Persisters	53.667	68.368	60.65
Nonpersisters	18	22	40
	59.444	60.636	60.1
TOTALS	39	41	n = 80
	56.333	64.22	60.375

In Table 27, the scores for questionnaire item 14, satisfaction with grades, are much lower than the scores reported for questionnaire items 12 and 13 (Tables 23 and 26). Although the total female mean (64.2) is higher than the total male mean (56.3), the differences in the mean scores are not significant, as indicated in the results of a two-way ANOVA (Table 25).

It should be noted, however, that both persisters and nonpersisters indicated low levels of satisfaction with their grades. This may be attributable to the level of competition that exists at a major research institution such as UCSD, especially in the fields of science and technology.

Table 28

The Results from Questions 18-23 on Questionnaire

Question	X^2	p
18. OASIS Services	1.46	
19. Tutor: OASIS	7.67*	.01
20. Teaching Assistant	5.54*	.02
21. Advance Placement	5.01*	.02
22. Access to Computer	0	
23. Other Student Services	.082	

n = 80

df = 1

Although the questions as outlined in Table 28 were not related to any specific hypothesis, the results can be used to supplement the information on what activities support persistence. The significant chi-squares on items 19, 20 and 21 are indicative of the fact that being a tutor, teaching assistant, or coming to the University with advance placement are favorable to those who are persisters. It would mean that these activities are part of the characteristics that describe persisters in the fields of science and technology.

Results from Group Interview

During the interview sessions, the researcher was unaware of the classification (persister or non-persister) of the group members. Not classifying the groups prior to the interview sessions was deliberately done, first, because subjects were allowed to set their appointments according to

their schedules, and second, to provide for a variety of interaction in order to solicit a broad perspective to the interview questions.

Subjects were asked to respond to the following three questions:

1. Do you believe that you can distinguish science and technology students by college affiliation?

2. Share with me some of your hobbies and interests that you feel have helped in your academic endeavors.

3. Name some of the things that you have done while here at UCSD that have confirmed your career choice.

In responding to these three questions, students indicated that college affiliation was not an observable factor; however, some individuals within the group felt that there are generally acceptable stereotypes that are attributable to students from each of the colleges. Since it was impossible to test these stereotypes, the recording of these factors was insignificant for the study.

The responses to questions 2 and 3 covered a wide range of categories. Any response that was given by three or more students is listed below. Responses were not coded to each individual but were tallied according to group participation.

Question #2. Hobbies and Interests.

1. Interest in model kits as encouraged by a parent or as a result of frequent gifts by other family members.

2. Visits to work sites or exposure to items that were job-related to a profession of one parent.

3, Being able to have an outside interest such as music or sports.

4. Love of science fiction books.

5. Love of space. Growing up during the televising of space shuttle flights.

6. The challenge of working on an engine, particularly cars, or taking things apart and putting them back together again.

Question #3. Activities while at UCSD.

1. Working in a lab on campus.

2. Being a teaching assistant (TA).

3. Knowing how to use the computer.

4. Being a resident advisor (RA).

5. Internship at Scripps Aquarium.

6. Producing a videotape program.

7. Working for a computer company.

The results from the group interview are indicative of the variety of experiences that the subjects in this study presented to the researcher. Some experiences were more important for specific individuals than for others. Overall, however, interest and hobbies along with job experience were classified as being important in the career choices of both persisters and nonpersisters.

In an attempt to discover why some students seem to be better able to handle the rigors of the science and technology disciplines, not considering intellectual ability, the three questions used during the interview process seemed appropriate and useful. Activities, interests, and hobbies are factors that were commonly considered as being influential in the choice of a career or vocation among the subjects of this study. However, the degree to which the above listed activities, interests, and hobbies influenced the choice was not ascertained. In the category of hobbies and interests, the responses did not appear to be very distinguishing for a group of students who were attracted to the fields of science and technology. The list of activities, however, seemed more likely to be chosen by those whose career interests lie in the science and technology area.

Results from Other Qualitative Data

There were other questions that were asked of subjects that were directed to addressing the research question of this study. On the researcher-designed questionnaire, questions 10 and 11 asked the subjects to name three things that aided or hindered their persistence in the science and technology field of choice. Results from these questions indicated that nonpersisters were hindered by the competitiveness, the grades, and the difficulty of the subject matter. Six out of ten students (60%) in each college indicated that this was the case for them. The fourth most

popular reason for lack of persistence indicated by 30% of nonpersisters was lack of interest in the subject matter. There were other factors listed by students that were more of a personal nature.

On the other end of the spectrum, factors that were frequently listed as contributing to the persistence of the persisters were the career and job opportunities (60%), family support (40%), and influence of the faculty (30%). Other factors such as interest in the field, money that could be made, and self-motivation were also named by a small percentage (1 to 2%) of subjects.

Summary

Results of this study did not support the hypotheses that persisters and nonpersisters differed significantly according to college affiliation, sex, or these two factors combined (hypotheses 1, 2, and 3).

The results of the study did not support the hypothesis that there is a significant difference between persisters and nonpersisters according to grade point average (hypothesis 4). This particular finding was not surprising given that if a student is doing well, as determined by his or her grades, he or she would tend to be persistent in the pursuit of his or her academic endeavors.

The results of this study did support the hypotheses that there are no significant differences between persisters and nonpersisters in terms of parental income and parental

educational background (hypotheses 5 and 6). The results also indicate that there is no significant difference between persisters and nonpersisters in terms of parental educational background when mothers and fathers are considered separately.

In regards to hypothesis 7, the results of the study support the hypothesis that there are no significant differences between persisters and nonpersisters based on the factors of peer group interactions, interactions with faculty, faculty concern for student development and teaching, academic and intellectual development, and institutional and goal commitments. When each factor was considered separately, however, the findings were that there was a significant difference between persisters and nonpersisters on the factors of interaction with faculty and faculty concern for teaching and development. The evidence suggests that persisters were more satisfied with their interactions with faculty than were nonpersisters. Furthermore, nonpersisters were not as satisfied with the faculty concern for student development and teaching. The results on this particular factor were not surprising, given the nature of a typical large research institution and the emphasis that is given to research rather than teaching, particularly in the fields of science and technology.

The results from the study did support the hypothesis that persistence is independent of academic comfort and

science-related interests as indicated by the scales from the SCII (hypotheses 8 and 9). The evidence indicates that persisters and nonpersisters were of average comfort level in the academic environment and that persisters and nonpersisters were close in their ranking of science-related interests.

In response to the questions concerning confidence in their ability to persist, the results showed that persisters different significantly from nonpersisters, as indicated by the results from an ANOVA, $F(1,78) = 5.64$, $p < .02$. One factor that was important, however, is that both male persisters and nonpersisters had above average scores, while only female persisters scored above average in their rating of their confidence in their ability to persist. This factor might also be reflective of the concept of male dominance in the fields of science and technology and the fact that females are not expected to be as strong academically in these disciplines. In response to another question concerning the three factors that aided their persistence, the findings show that 60% indicated that career and job opportunities were most important, 40% family support, while 30% indicated faculty influence. The three factors most frequently listed by 60% of nonpersisters as hindering persistence was competition, grades, and difficulty of the subject matter.

CHAPTER FIVE

CONCLUSIONS, DISCUSSIONS, RECOMMENDATIONS

This study was designed in order to determine the characteristics that distinguished persisters from nonpersisters in the fields of science and technology. By utilizing the concepts of academic and social integration as identified by Tinto (1975), several factors were isolated and tested in order to create a profile of characteristics.

Juniors who had indicated a science and technology field as their incoming major, who were currently enrolled, and who were currently in a science or technology curriculum were considered persisters for this study. Subjects who were also juniors, who had indicated science and technology as an incoming major, who were currently enrolled, but who had changed majors to fields outside of science and technology were considered nonpersisters. A random, stratified sample of 162 persisters and 92 nonpersisters was chosen from the four colleges at the University of California, San Diego. A mailed questionnaire, a survey, and a standardized vocational interest test were the instruments used to gather data. After surveys and questionnaires were returned and interviews and testing completed, a total sample of 80 students was selected for analysis. This sample included representatives from each of the four colleges at UCSD divided by persistence factors and sex.

The mailed questionnaire was a researcher-designed instrument used to gather personal and demographic information. The survey, designed by Pascarella and Terenzini to predict persistence among freshmen, was used to measure students' academic and social integration in a university environment. The Strong-Campbell Interest Inventory, a vocational and career interest instrument, provided data on career interests of the subjects.

The research question asked, "What are the effects of college choice, parents' income level, parental educational background, GPA, and sex on persistence of students in the science and technology fields?" To answer this question, three major areas (demographic, college environment, and student interest) were analyzed. A discriminant analysis was developed using the environmental variables as measured by the Pascarella and Terenzini survey. The results were insignificant; therefore, a model of students characteristics that could be used for prediction, based on the college environmental factors as measured by the Pascarella and Terenzini scale, was not created. There were no significant differences found for persisters and nonpersisters in the area of parental income level, parents' educational background, sex, and college choice. An ANOVA was performed on the GPA data. The results indicated that persisters' GPA (3.16) was significantly higher than nonpersisters' (2.89), $F(1,78)=8.25$, $p < .01$.

Further analysis was conducted on the results from the SCII. A chi-square analysis was performed on the results from the academic comfort scale of the SCII. There were no significant differences between persisters and nonpersisters according to the results. The results of a t-test on the science related interest scale of the SCII indicate that there is a significant difference between persisters and nonpersisters based on the four factors of the investigative category.

In the area of student interest, a few factors emerged. Three items from the questionnaire that provided useful information were the subjects' rating of their satisfaction with grades, the confidence in their ability to persist, and their satisfaction with their choice of college. The subjects' ratings on these three items indicated high satisfaction with their choice of college but low satisfaction with grades. There was a significant difference between persisters and nonpersisters with regard to confidence in their ability to persist.

Other responses in the area of student interests were those that were identified by the subjects during the interview process. The responses were varied, but there were several comments that were consistent from group to group. Activities such as working on a lab on campus, being a teaching assistant, doing an internship, and being a student leader or resident assistant were responses that were re-

ported by several of the group. It is important to note that students were not identified as persisters or nonpersisters during the interview. Once all the data were collected, the results were compiled and listed. A further review of the names from each group session was then used as an indication that the group or individuals adequately represented persisters and nonpersisters. The findings from the interview questions suggest that both persisters and nonpersisters have similar hobbies and interests. The activities that helped to distinguish the persisters from the nonpersisters were those that were mentioned as opportunities that came while the student was on campus that helped him or her remain in his or her chosen major.

Individual and group interviews were conducted at the administration of the SCII. Subjects' responses were recorded and tallied. Being able to participate in extra-curricular activities such as sports was important to both persisters and nonpersisters. Neither group perceived any distinguishing characteristics among students from the four colleges.

Discussion

The results of this study are indicative of the complexity of information concerning factors that contribute to persistence among college students. Factors such as student interests, demographic and college environmental considera-

tions are all issues that determine the persistence of individuals within a chosen field or major.

At an institution such as the University of California, San Diego (UCSD), the complexity of information that surrounds the issues as they relate to persistence requires a close look at each factor. As one of the eight campuses of the University of California, UCSD traditionally draws its population from the top 12% of high school seniors from both public and private schools in the state. In addition, the institution is known for its resources and distinguished faculty which helps to attract not only the more academically gifted but the more affluent student as well.

Choice of College

Choosing a college at UCSD could be compared to choosing a college campus or college environment at some other institution. Students tend to be attracted to environments that support their needs or expectations. There were no significant factors that seem to differentiate among students from the different colleges. This was perhaps particularly true because of the preselected group of students in the science and technology fields. What seemed to be most apparent was the commonality of interests in major fields rather than the distinction and association of the general education requirements of each of the colleges. This issue was supported when during the interview session students were asked to describe or characterize students

from the four colleges who shared a common major field. The general response was that this is difficult to do because there are no obvious characteristics. The overall response to the question as to why the student chose a particular college was the general education requirements. It is important to point out that the respondents were all juniors who were well within their fields of study; therefore, their connection was now through the discipline rather than through the particular college.

Parental Education

In regard to parental educational background, the higher frequency of parents with degrees among persisters might be indicative of a propensity for educational achievement within the given population studied. Whether measured in terms of educational plans, degree expectations, or commitment to college completion, research has consistently revealed that the higher the aspiration of a student, the more likely he or she is to remain in college (Astin, 1977; Peng & Fetters, 1978; Tinto, 1975). In other words, students of parents who are college graduates might be more inclined to persist in the endeavors to match their parents' achievement or even surpass that achievement.

College Environment Factors

In the area of environmental interests, the results based on the overall score of the Pascarella-Terenzini survey indicate that there were no significant differences

between persisters and nonpersisters. There were no differences between persisters and nonpersisters in the subscales on Peer Group Interaction, Academic and Intellectual Development, and Institutional and Goal Commitments of the Pascarella and Terenzini Survey. There were significant differences between persisters and nonpersisters, however, on two of the subscales: Interaction with Faculty and Faculty Concern for Student Development. The Pascarella and Terenzini Survey has been used mainly as a predictive tool for success among freshmen. Students from a variety of academic orientations and in large populations have been surveyed by the use of this instrument. This instrument was used in this study as a measure to distinguish known persisters and nonpersisters in terms of their commitments to the college environment. The similarity of the subjects (i.e., all were incoming science and technology majors) seems to limit the ability of this instrument to be more discriminating on several of the academic integration factors.

In their theoretical models, Spady (1970) and Tinto (1975) suggested that one important positive influence on students' levels of social and academic integration is the extent of their informal contact with faculty beyond the classroom. These contacts would then foster important interpersonal links between students and the institution, which in turn would lead to greater institutional commitment

and an increased likelihood of persistence. Persistence in this study is related to perseverance within an academic discipline. It is therefore conceivable that the distinction between persisters and nonpersisters would be significant in the area of faculty interaction because juniors, the subjects of this study, are usually immersed within their major areas of study and should be familiar with the faculty of their particular discipline.

Pascarella and Terenzini (1980), in a study that validated Tinto's (1975) and Spady's (1970) models of college attrition found that the pattern of influences of informal contact with faculty appeared to differ by sex. For men, frequency of informal contacts with faculty to discuss their future careers and to obtain information about courses and academic programs was positively related to freshman year persistence. For women, the purpose of these informal contacts having significant partial correlations with persistence/withdrawal decisions appeared to be directed more toward intrinsic than instrumental outcomes. The findings from Pascarella and Terenzini's (1980) study suggest that a different pattern of interactions with faculty associated with male and female persistence may to some extent reflect differences in perceived needs for developing a sense of career identify during college. In this particular study the findings, as determined by the results of the Pascarella and Terenzini survey, suggest that persisters viewed the

concern of faculty for student development as more significant than did nonpersisters. Further implications are that those students who decided to remain within science and technology disciplines were satisfied with the interactions with faculty, as opposed to those who left the scientific academic areas. The findings, however, do not allow for a conclusion as to whether students left the area as a result of this interaction or whether this expression of dissatisfaction came after students left the majors. The findings from this study did not distinguish between male and female persisters and nonpersisters in terms of relating to faculty interaction; therefore, it was impossible to support Pascarella and Terenzini's findings of the influence of informal contact with faculty which appeared to differ by sex.

Since the decision to remain in or to change a major was made by subjects prior to this study, it was hypothesized that the characteristics that distinguish persisters from nonpersisters would be more apparent in a group of junior level students rather than in freshman students.

In any academic discipline, student characteristics are important for success and persistence. In the science and technology majors, as determined through this study, the student characteristics that emerged as factors that distinguished persisters and nonpersisters were self perception and grades.

Future research suggestions would be to isolate the factors of self-perception through personality or motivation measures and to test the group of persisters and nonpersisters for differences. Another possibility would be to compare freshmen in terms of their self confidence and grades and later repeat the process during the junior year and note the differences. These factors -- confidence in one's ability to persist, and grade point average -- were identified through subjects' responses to the researcher-designed questionnaire. Analysis of the results indicated that self-confidence was significantly higher for persisters than nonpersisters.

Vocational Interests

It was also interesting to note that persisters identified themselves as being more involved with jobs that related to their careers. Hobbies and interests that also contributed to persisters' pursuit of a scientific or technological career seemed to be common among the group. The concept of the self-fulfilling prophecy is supported here. That is, having confidence in one's ability, being supported by either a faculty member or parent, having a part-time job in the area, and being encouraged by receiving good grades eventually leads to achievement of the perceived goal. The question, however, is whether nonpersisters lack self-confidence or whether the pursuit of a major that was not motivated by their interests or abilities contributed to their

lower self-confidence. The results from the SCII show that nonpersisters were strong in their interests in science-related careers. This could be interpreted that the rigorous academic requirements might be the one factor that mandates the shift in a major regardless of parental factors, sex, college choice, or career interest.

Academic integration, a term that has been suggested by Tinto (1975) as one of the components of persistence, is often measured by normative factors (grades, sense of competence). A sense of competence is developed through interaction with others and is essentially the level of productivity and effectiveness an individual feels he or she has when performing intellectual, interpersonal, or physical tasks (South, 1975). Grades are an objective standard against which the individual student can evaluate his or her sense of competence, which is usually established in interaction with others. The results of this study show a significant difference between persisters and nonpersisters in terms of GPA. The importance of grade performance in fostering persistence is related to pressures for future occupational development, particularly in men (Spady, 1970). Science and technology occupations are viewed by many as desirable and generate high income level positions; therefore, it is not surprising that having high grades would be a significant characteristic of persisters in science and technology.

Recommendations

The advancement of scientific and technological disciplines has spurred the interest of young people seeking knowledge and challenges in institutions of higher learning. The University of California, San Diego is known locally and nationally as an institution which contains both students and faculty who are challenged by the new approaches and discoveries that have been linked to fields of science and technology. It therefore seemed appropriate to use this testing ground of potential future scientific experimenters in which to develop a profile of characteristics that distinguish students who are most likely to persist in scientific curricula.

The results of this study are limited to the type of institution studied and the population sampled. Although the subjects of this study were taken from the population at UCSD, some of the data can be applied to those who are inclined toward, or interested in, scientific and technological disciplines. Further research studies of attitudes, personality types, and motivation of both persisters and nonpersisters would lead to a more comprehensive and detailed understanding of potential candidates and could be utilized to design a descriptive evaluation tool for admission purposes. There are several factors that are influential in the decision making process when choosing which university or college to attend. Some of these factors are,

yet are not limited to, the following: parental support, both financial and psychological; family affiliation with the institution; proximity to home town; tuition rates; reputation of the institution, both social and academic; and the choice of academic major or career interest.

In choosing a major, a student is more likely to focus on his or her academic ability and vocational interest. What, then motivates a student to continue or carry out these decisions once they are made? Self-confidence is one factor that has contributed to success and perseverance in an academic setting.

One area in which the results from this study demonstrated a significant difference between persisters and non-persisters was in the area of confidence in their ability to be persistent. A program that would focus on the building of self confidence in academic ability could be initiated through the academic counseling function at a college or university. Students entering an institution of higher education are usually unaware of the rigors of college and particularly the curriculum within their choice of major. Early during the freshman year, it could be useful to present a series of profiles of individuals who have persisted in several majors within the science and technology fields. One such profile might be the following:

> Female student, interested in bioengineering as a major, interest was sparked by a high school tea-

cher who recommended that she attend college, father is an engineer, mother is a college graduate working for a large company in the management field, worked in a lab during sophomore and junior years, was confident in choice of major when she entered, managed to maintain an average of 2.7 to 3.3, had hobbies and interests that were both related and unrelated to her major, felt that faculty were concerned about her academic development.

Another profile might be:

Male student, not sure of career motivation, good at math and science in high school, mother graduated from college with a major in education, father works in industry, works on campus in the college cafeteria, average grades (C+/B-), likes music and plays the guitar, has been considering a biology or chemistry degree.

Yet another:

Female student, good athlete, played on high school volleyball team, wants to be a doctor, first in family to attend college, works as a student resident advisor in the residence halls, knows most of the faculty in the biology department, participates in group study skills support center.

These profiles could be included in admission-type brochures. The information would also be helpful during freshman orientation and other freshman experience seminars. Exposure to this type of information prior to coming to college would be useful to students who are unsure of their academic strengths and the rigors of science and technology curricula.

This approach would present several characteristics that could be considered common for most students. It would be necessary to clarify that these profiles are not exclusive but that those factors that emphasize both the social and academic integration of the student to the college environment is most important for persistence.

The use of these profiles as confidence boosters, along with the basic information that is available to the academic counselors through individual files, may provide a successful intervention strategy for increasing the number of persisters. As indicated by the results of this study, the confidence level of females was not as high as the level for males. One strategy for intervention would be a self-assessment and confidence enhancing program specifically designed for females in science fields. This program would incorporate a support network of both staff and faculty for females in the science and technology areas utilizing female role models who are currently in the field both inside and outside of the institution. The development of a mentor

program would also be an ideal way to encourage and support the confidence level of females interested in the fields of science and technology.

In the area of undergraduate admissions, the current increase in the number of applicants to universities and particularly to disciplines within the science and technology fields has mandated that screening processes take into account other factors besides high school GPA and test scores. As indicated from some the findings of this study, the factors that showed a significant difference between persisters and nonpersisters were factors of course performance (GPA), self confidence, and perceptions of faculty interest and concern. These results would indicate that it is not the demographic factors that distinguish the persisters from the nonpersisters; rather, it is the performance factors while within the academic environment that seem to effect the differences. In addition, the results of the Strong-Campbell Interest Inventory showed that persisters and nonpersisters maintained a high interest level in mathematical and scientific careers. This information would be useful when trying to formulate admission criteria for students who are applying for admission to the science and technology disciplines. Further research studies of attitudes, personality types, and motivation of both persisters and nonpersisters would lead to a more comprehensive and detailed understanding of the characteristics of poten-

tial and could be utilized to design a detailed evaluation tool for admission purposes.

One area that distinguished persisters from nonpersisters was that the nonpersisters felt that the science and technology courses were "hard." Another factor that was common to both persisters and nonpersisters was "low satisfaction with grades." These two issues are indicative of a concern that has surfaced in institutions in which the emphasis on excellence is correlated by students and others to a 4.00 or "A" average. The need to interpret excellence is beyond the scope of this study; however, there is some indication, as evidenced by the results of this study, that students should be more informed about the rigors of the science and technology disciplines. Tutorial services, such as those provided by departments or academic skills centers, should be encouraged. Freshmen should be assigned to a faculty advisor, particularly within their major emphasis. Access to teaching assistants (TAs) should be encouraged and fostered by faculty within these disciplines. The art of teaching should be emphasized in the science and technology curricula so that learning becomes more important than the grades early on in the student's orientation to the discipline.

In the area of student/faculty relations, the results indicated that there were significant differences between persisters and nonpersisters in their satisfaction with the

interaction with faculty and faculty concern for student development and teaching. Again, the need for faculty mentors or advisors early on in the student's orientation to the institution is encouraged. More opportunities for students to be part of projects that are conducted by faculty continues to be an important part of career development for students. The prestige of working in laboratories has been mentioned as a factor leading to persistence by some students. This opportunity should be expanded, along with other work opportunities. The idea of an internship in the science and technology fields has been limited because of the intense requirements in such curricula. Perhaps an extension or expansion of the internship programs which emphasize the variety of scientific research and technical industries within close proximity to an institution would be one way to help students interested in these majors to make well-informed decisions concerning their future careers.

An institution where freshman orientation is a prerequisite to enrollment should include faculty advisors as part of its program. This process serves to establish a link between the student and the faculty, and the same clarifies for the novice student the expectations, the requirements, and the commitments for success in a curriculum area such as science and technology. Another area of intervention that has been utilized by liberal arts and social sciences is the establishment of living learning

centers. These centers are usually developed in conjunction with an academic department and the student affairs division. Students are selected to participate based on their academic interest or social philosophies. Classes are held within the facility, and faculty are usually invited to live in one of the central buildings. An adaptation of this concept with science and technology as a theme might be amenable to students in a living unit. Classes that did not require a laboratory could be held within the complex, and faculty would be invited to live in. Seminar rooms, computer rooms and any other services that could complement the academic program could become part of this complex. Students would be able to have all the support needed to succeed within their chosen major directly within their living area.

Recommendations for Further Study

After reviewing the results of the study, there are several areas that can be further investigated on the subject of persistence of science and technology students. One factor that was not developed was the variable of ethnicity. In this study, the majority of students were white; perhaps a more representative sample of students from a variety of ethnicities might produce different results.

The design of the study was also limited. Although survey research is more common, it is difficult to get a high percentage of return on surveys unless there's a cap-

tive audience. In this study, there was less than a 50 percent return. One suggestion would be to have the test and survey information administered in a classroom. Another suggestion for further study might be to provide incentives for returning surveys. Yet another suggestion might be to utilize a population that might be more willing to participate; for example, freshmen during orientation sessions.

Some other issues to consider would be to have the number of males and females more evenly matched by college. An addition of questions and more discriminating test instruments might provide a researcher with enough data to develop student profiles.

Conclusions

In the beginning of this study, several questions were asked. One question was: "Can students who will be successful in the science and technology disciplines be identified prior to enrollment?" This study was unable to find a model that could be used as a predictive tool that could be applied to all incoming applicants in the science and technology fields; therefore, the answer was negative.

Another inquiry made was, "Should some criteria be used to dissuade those who appear to be unable to handle the academic rigors that are characteristic of study in the science and technology area?" The results of the study indicate that the factors that contribute to persistence are so varied and individualistic that it might be wise to perhaps

encourage those who might have the potential for success to seek intervention programs rather than not to try at all.

In the fields of science and technology, confidence in one's ability to succeed, interaction with faculty, and involvement in work-related activities such as laboratory assistantships and teaching assistantships leads to persistence. The demographic factors such as parental income and educational background do not determine persistence but are factors that have contributed to the choosing of fields in the science and technology area. Vocational interest and career aspiration are important elements in persistence in the science and technology fields, as evidence by significantly higher scores on the Investigative scales of the Strong-Campbell Interest Inventory by persisters. On the other hand, nonpersisters continued their interest with the math-related majors, as evidence by the greater numbers who chose management science and economics as alternate majors.

There is no one formula that can predict persistence in the fields of science and technology. Some institutions provide an environment that fosters growth and success for some students. Finding that college environment that is best suited for an individual and his or her career interest may yet prove to be the most important element in one's college career.

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Appendix A

The College System at UCSD

Appendix A

The College System at UCSD

Revelle College, one of the four colleges within the academic structure at UCSD, is dedicated to the concepts of high achievement and success within the fields of science, mathematics, and technology. It is said that students come to UCSD, and particularly Revelle, because of its reputation, both statewide and nationally, for excellence in science and technology. At Revelle College, general educational requirements are designed into the curriculum in the areas of writing, humanities, social sciences, mathematics, physical and biological sciences, fine arts, and foreign language.

John Muir College, the largest of the colleges at UCSD, adheres to an educational philosophy whose emphasis is on individual choice and development while assuring breadth and depth in learning. Muir's attractiveness is the freedom of choice in the development of a broad and liberal general education requirement. As indicated in the UCSD Catalog, under Muir's general education requirements, each student must complete four year-long sequences (three courses each). The sequences are selected from among six general categories, within which is a wide variety of choices.

Third College, another of the colleges at UCSD, prepares students for a complex and changing world by providing a broad liberal education, complemented by in-depth study in

areas of the student's own choice based on academic interest and career goals. Third College enables students who have well-defined majors, interests, and career goals to begin work on their majors as freshmen. Third's dedication to the establishment of a multiracial, multicultural academic community has attracted a diverse group of students.

Warren College's approach to study has been one in which the career goals are linked with the undergraduate education. The Warren curriculum gives the student a wide range of options, but once the student has selected areas of interest, somewhat more specification within those areas is required than at the other colleges. Students come to Warren because the college is committed to preparing them for the post-baccalaureate years. One special way in which it does this is through the academic internship program. This program gives students the opportunity to work in areas outside the classroom, such as attorneys' offices, government agencies, and other areas for one or more quarters while earning academic credit.

Appendix B

Letters to Students

UNIVERSITY OF CALIFORNIA, SAN DIEGO

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

UNIVERSITY OF CALIFORNIA, SAN DIEGO
OFFICE OF THE RESIDENT DEAN B-012
REVELLE COLLEGE

LA JOLLA, CALIFORNIA 92093

October 23, 1985

Dear

I've thought about several ways to approach requesting your help, but they all seem to be too much of a part of the Madison Avenue gimmick approach and uncharacteristic of who I am. So, I decided that I should use the one and only correct way and that is the direct method.

I need your help. Attached is a Questionnaire and Survey that I need you to fill out and return to me. I am collecting data that will be used in my doctoral research that might prove to be very interesting to science and technology majors. Although you may have changed your major, your input is still urgently needed. So, please send the Questionnaire and Survey back to me in the enclosed envelope within two weeks after you receive this letter.

Make note of the four group sessions listed on the attached Questionnaire and Survey and schedule yourself to attend one of these meetings. If you have any questions or problems, please call me at 452-3025 (8:00 a.m. - 4:30 p.m.) or at 453-0245 (6:00 p.m. - 11:00 p.m.) — or if you are in the area, please feel free to come by the Revelle Resident Dean's Office in Blake Hall.

Again, I need your help, and I will appreciate your input. If you would like more details or even the results of my study, please feel free to contact me.

I look forward to your prompt response.

Sincerely,

Judith W. Edwin
Revelle Resident Dean

JWE:vb

Attachment

(I have dreams of graduating, too, so please don't forget to come by the office).

Dear _____ Date _____

Thank you for responding to my survey. And for those of you who have either lost or misplaced the survey form, please call me or come by the Resident Dean's Office and pick up a new form.

On January 6, 7, 8, and 9, 1986, I am conducting interviews and inventory sessions in the Resident Dean's Conference Room in Blake Hall from 8:30 a.m. - 4:30 p.m. Your participation is greatly needed.

Please call me at 452-3205 (Office)
453-0245 (Home)

1986

Dear

Several times I have approached you to request your help with my doctoral research, but I have not yet received a completed Questionnaire and Survey from you; nor have you completed the Strong-Campbell Interest Inventory.

Frankly, I need your help. I am enclosing a Questionnaire and Survey that I need you to fill out and return to me. I am collecting data for my doctoral dissertation, which may prove to be of great interest to students majoring in scientific and technological fields. Although you may have changed your major, I still urgently need your input.

Would you please help me by filling out the brief Questionnaire and Survey and returning them to me? Also, I would greatly appreciate it if you could call me at 452-3025 (8 am to 4:30 pm) or 453-0245 (6 pm to 11 pm) to set up a mutually convenient time for you to take the Strong-Campbell Interest Inventory. In case you are not already aware, the SCII is a test which asks you questions about your interests and attitudes in order to determine what careers you may be suited for. Other students who have taken the SCII in the past have found it enjoyable and informative, and I would be more than happy to give you a copy of your individual results for your perusal. The test takes only 30 minutes to complete.

In order to elicit the maximum response to this letter, I will pay five dollars ($5.00) to each student who completes the Survey, Questionnaire, and Strong-Campbell before June 15, 1986.

I am looking forward to your prompt response.

Sincerely,

Judith W. Edwin
Revelle Resident Dean

JWE/wal
Enclosures

Appendix C

Instruments Used in the Study

STUDENT QUESTIONNAIRE AND SURVEY

Name_____ Sex_____ Age _____ Ethnicity _____

Permanent Address _____ State _____ ZIP _____

Incoming College _____/Present College _____ GPA _____

Incoming Major _____/Present Major _____

1. Parents Combined Income:
   (K=Thousand)

   _____ _____ _____ _____ _____
   0 - 20 20 - 40 40 - 60 60 - 80 Above 80

2. Highest Degree Completed:

   Mother: None ____ B.A.___ B.S.___ M.S.___ Ph.D. ___ PROFESSIONAL ____

   Father: None ____ B.A.___ B.S.___ M.S.___ Ph.D. ___ PROFESSIONAL ____

3. Highest degree you expect to complete?

   B.A. ___ B.S.___M.A.___ Ph.D. ___ PROFESSIONAL ____

4. What is your career goal? _____

5. What field of science or technology? _____

6. How did you decide on your major? Self__Parents__Counselor__Friend__Other__

7. What factors attracted you to UCSD? Academic Reputation__College Choice__
   Programs & Activities ____ San Diego Climate___Social Life___Other _____

8. How did you choose which college to attend? _____
   _____

9. What attracted you to the science and technology discipline? _____
   _____

10. What three things aided your persistence in the science and technology field?_____
    _____
    _____

11. What three things hindered your persistence in the science and technology field? _____
    _____

(please continue on reverse side)

12. If you took a retrospective look at your attitude as a Freshman, how would you rate your confidence in your ability to persist in your major?

(Scale 1 - 99 rate) Rate _____

13. Rate your satisfaction with your choice of college:

(Scale 1 - 99 rate) Rate _____

14. Rate your satisfaction with your grades:

(Scale 1 - 99 rate) Rate _____

15. Rate your skills in computer competence on your persistence in terms of the value of importance:

No Value__Little Value__Average Value__High Value__Tremendous Value__

16. How would you rate the effect of the computer on your persistence?

None __Little Effect__Same Effect__Effective__Very Effective ____

17. If you have changed colleges, give reasons for change: _____

_____

18. Have you used the services of OASIS? Yes_____ No _____

19. Have you been a tutor for OASIS? Yes_____ No _____

20. Have you been a teaching assistant? Yes_____ No _____

21. Did you receive advance placement as a result of pre-college courses?

Yes_____ No _____

22. Did you have access to a micro computer prior to college?

Yes____ No _____

23. Do you use other student service offices?

Yes____ No _____

If yes, how often? _____

_____

Site	Group Sessions	Date & Time/Sign-up Time	Check One
Revelle Campus (Formal Lounge)	I	November 11/4 - 6:00 p.m.	____
Muir Campus (Apartment Lounge)	II	November 12/4 - 6:00 p.m.	____
Third Campus (Mountain View Lounge)	III	November 13/4 - 6:00 p.m.	____
Warren Campus (Resident Dean's Office Lounge)	IV	November 14/4 - 6:00 p.m.	____

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